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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Rustless Iron and Steel.

An important contribution to the study of acid and rust resisting material was made in a Paper presented by MR. J. LONGDEN to the London Branch of the Institution of British Foundrymen last Thursday. The most important suggestion he enunciated was the manufacture of high-silicon alloys under such conditions that the control of the carbon could be more easily effected than is the case when cupola melted. Under such conditions it is possible that a better material may be produced, but it is not at all certain that a really important gain in strength would be produced, and its field would still be limited to its present applications and would not compete seriously with the field now occupied by the high chromium rustless iron.

We have previously put forward in this column the possibility of cupola melting a metal of the composition of chromium rustless iron, except for a high carbon, for the sake of the incorporation of relatively very cheap high carbon ferro-chrome and then decarbonising the castings made, by means of the Reaumur malleablising process. Since this time experiments on this line have been carried out, but it was found that the carbides of chromium were impossible of dissociation. The last issue of "Chemical and Metallurgical Engineering" to reach this country contains an account of some work carried out by Louis Jordan and F. E. Swindells under the auspices of the American Bureau of Standards, with the object of reducing the carbon in ferro-chromium by hydrogen. Experiments were made to ascertain the effect of heating ferro-chromium in an atmosphere of hydrogen at high temperatures. Certainly some reduction on what we presume to be the powdered form was found, but commercially the results were a failure. Experiments were continued by blowing hydrogen through molten ferro-chromium and a reduction of nearly 1 per cent. of carbon on an 8.4 per cent. original content. As the time of blowing was only four minutes, the process, if continued, might have shown good technical results, especially as they were confirmed by surface blowing for 20 minutes, which resulted in the same material having its carbon content lowered over 1.5 per cent. Again, however, we see small chance of the commercial exploitation of such a process. If success is to be achieved by any pneumatic system it is the Krupp patented process which appeals to us. This process is based on Bessemer's original idea of reducing carbon by blowing air through pig-iron, the modification being that cheap or high-carbon ferro-chrome is melted and blown with the production of the dear or carbon-free material. From experiments which we have conducted, we have found that there is a very considerable loss of chromium. The electric furnace, too, presents a useful experimental plant, using iron- or chromium-ore as an oxidising medium for the carbon, but when working with ferro-chromium an equilibrium appears to be set up about 2 per cent., beyond which it is difficult to go. Again, when working with steel scrap and high carbon ferro-chromium which gave a 2 per cent. carbon content in the bath, the oxidation process proceeded satisfactorily until the carbon had been reduced to 0.5 per cent. Here an equilibrium was set up with which was impossible to break down, and the material had to be teemed and remelted, when no difficulty was experienced in arriving at 0.28 per cent. carbon. We believe that other trials have been successfully made by using chromium ores instead of iron ores. The problems of making rustless iron or steel without using carbon-free ferro-chromium or by making this material cheaply from low-grade alloys are metallurgically fascinating. Especially so is the latter, as one has more than £50 per ton with which to cover manufacturing costs before the difference in market value of the cheapest and dearest disappears. Foundrymen must realise that this subject is not wholly for the ingot manufacturer, as castings are being made in this rustless material. Efforts are being made to cast propellers in rustless steel, and if the largest sizes are to be made, then an effort to utilise low-grade ferro-chrome assumes the highest importance.

High or Low-Pressure Sand Blasting.

Some little time ago the balance of foundry opinion was in favour of high-pressure sand blasting, as figures were produced showing that more metal was removed per given horse-power employed. However, the latest advices from the States seem to indicate that the pendulum is now swinging back again to lower pressures. Messrs. Tilghman's Patent Sand Blast Company, Limited, of Broadheath, have recently published a statement on this subject, which presents considerable interest for foundrymen. The brochure points out that factors necessary to be studied are the actual economy of the sand-blast machine itself, the cost of the compressed air used, and sand worn out by the machine, and the amount of sand-blast power that can be conveniently put into the hands of one man so as to reduce the wage cost of the operation.

Sand Impact Proportional to Necessary Work.

One pressure of air is not the most economical for all uses. The grain of sand must deliver a blow of a force properly proportioned to the work that it is expected to do. A given horse-power of compressed air will impart a certain velocity to a given weight of sand per minute and no more. If this velocity is sufficient, then doubling the velocity of the sand will reduce the factor of economy of the machine to 25 per cent. of its former efficiency for these reasons. At double the velocity, each grain of the flying sand will contain four times the energy as the same grain at the lower velocity. The total quantitv of sand to which it can impart this velocity, therefore, will be only one-quarter that to which it can impart the lower velocity. As at the lower velocity, the sand has sufficient energy to do the work required of it; with greater energy it can do no more, and the extra energy imparted to it is only wasted.

Additionally, there are other sources of waste; for instance, there is more "slip" between the sand and the impelling air at higher than lower velocities. At lower velocities the comparatively lower pressure air imparts more nearly its own velocity to the sand than does the higher pressure air moving at a greater velocity. This can readily be appreciated by the fact that at the lower pressures, say at about 10 to 16 lbs. per sq. in., when the machine is running without sand, when the sand is turned on, the pressure will be found to rise from 25 to 30 per cent., or to 14 to 20 lbs. per sq. in. Whereas when the machine is running at about 80 lbs. to the sq. in., the rise of pressure is scarcely perceptible, not over 2 or 3 per cent., when the sand is turned on. In no other kind of machine would a machine that consumed 97 per cent. of its power load when running empty be put forward as an economical machine. These conclusions were the cause of the low- or moderate-pressure machine being developed, and a long course of comparative experiments fully verified them.

Pressure and Hose Pipe.

These conclusions are true of any type of sand-blast machine, but with the flexible hose type of machine they are still more intensified for the following reasons:—

In any event, the long flexible hose is source of loss of power for the obvious reason that every time a grain of sand strikes the soft elastic lining of the hose it loses a very considerable portion of its velocity and drops back into the current at a reduced velocity, which must be again imparted to it if it is not to drop and, by a repetition of the process, finally come to rest and clog up the tube. For this reason, the larger the diameter of the hose, and the less velocity of the mixed stream of sand and air passing through it, the less is this loss, for the reason that the larger the hose, the greater the ratio of its cross-section to the area of its walls; and therefore the fewer are the impacts of the sand grains passing through it with its walls, and also owing to the low velocity, the less is the loss at each such impact. As an illustration, in a low-pressure machine a hose 2½ in. internal dia. passes 180 cub. ft. of free air compressed to 14 lbs. per sq. in. per min.

When the sand is turned on, this air carries with it about 35 lbs. of sand per min., and the pressure rises in discharging the same amount to about 20 lbs. per sq. in. This mixed stream is discharged through a ⅜-in. nozzle. With a "high-pressure" machine having a hose ¾ in. dia. it carries an unspecified amount of air at 80 lbs. per sq. in., and discharges it through a nozzle 3-16 in. dia. The increase of pressure, when carrying sand, would be practically imperceptible, and the amount carried could not possibly be more than 6 or 8 lbs. per min., probably much less. This forced through a tube of only 0.09, the area of the low-pressure hose width, it is easy to see what a loss of velocity and wear on the tube from the fact that the machine will not work at all if the pressure is reduced very much below the specified 80 lbs. per sq. in. When discharged, the sand has not to exceed an efficiency, weight for weight, of more than 1¼ to, at most, 1½ that of an equal weight of sand discharged from the low-pressure machine, or a net cleaning power of, at most, one-third that of the latter machine at the same cost of air and a greatly increased cost for sand and hose, which the higher pressure wears out much more rapidly, and at a wage cost, if in each case one man handles one hose, of three times that called for by the low-pressure machine. Including wages, air, sand and hose, this type of machine will cost nearly or quite six times as much per sq. ft. of cleaning ordinary castings, forgings, etc., than the L.P. machine.

Another aspect which illustrates the inherent waste of the former class is as follows:—The air that is discharged at a considerable velocity from the nozzles of either class of machine is itself of considerable weight, namely, about one-thirteenth of a pound for each cub. ft. of free air before compression. Taking the machine discharging 180 cub. ft. of free air per min., this air will weigh about 14 lbs. It is discharged at practically the same velocity as the sand with which it is mixed. The force necessary to give velocity to the air is in itself without effect in sand blasting. Only the force which is imparted to the sand is useful. It is therefore self-evident that a machine which discharges a mixture of 14 lbs. of air and 35 lbs. of sand per min. transforms somewhat over 70 per cent. to the total force put into it in giving useful velocity to the sand it discharges, and wastes only somewhat less than 30 per cent. in incidentally imparting velocity to the air that is discharged along with it. Whereas a machine that discharges the same weight of free air per min. at the higher pressure mixed with only 6 to 8 lbs. of sand at a maximum utilises only 30 to 35 per cent. of the force in usefully throwing sand, and wastes some 65 to 70 per cent. of its force in uselessly throwing air at the same velocity. This is to say nothing of the fact mentioned above that, at the higher pressures, the sand does not so nearly get the same velocity as the air in which it is mixed and propelled as it does at a lower pressure.

Nozzle Considerations.

Another wasteful point of the high-pressure machine is the fact that it often uses a very short nozzle. It is evident that the higher the pressure and the greater the velocity sought to be imparted to the sand, the longer should be the nozzle through which the mixture passes, so that the air will have a longer time to act on the sand. The reason that this is not done is that, at the higher velocities, the wear of the flying sand is so destructive to the nozzles as to be more expensive, and therefore recourse is had to a short nozzle, thereby sacrificing economy and efficiency of action to secure a longer life to this part of the machine.

There still remains to be dealt with the question of the removal of the dust from the used sand and its re-use, and with the question is connected the conveying of the sand to the storage hoppers.

International Exchange Papers.

At a meeting of the General Council of the Institution of British Foundrymen, held at York last Saturday, it was decided that Dr. Percy Longmuir, Director of Research to the British Cast Iron Research Association, should present a Paper on their behalf. It was also announced that Major R. A. Bull, of the American Steel Founders' Research Group, would present a Paper on behalf of the American Foundrymen's Association to the Manchester Conference.

How Quality is Produced under Quantity Production Conditions.

By H. Cole Estep (European Manager of "The Foundry").

(*Continued from page* 469.)

American Basis for Management.

This system of control begins in the foundry with the appointment of a man of the broadest possible foundry knowledge and experience to the position of foundry manager, making him responsible only to the works manager or general manager as the case may be. In other words, he should be co-ordinate in salary and responsibility with the man in charge of the machine shop. Depending on the size of the shop, he should have a varying number of lieutenants in charge of the several foundry departments, such as the melting, moulding, core making, cleaning, etc., including the pattern making. A metallurgical chemist, capable of doing not only routine, but research work, is essential; on him rests the chief burden of obtaining a metal of the proper quality. In a large shop, a millwright's department is also necessary for keeping the machinery in order. The inspection and testing department is preferably independent of the foundry superintendent. If the plant is large enough, the several department heads are assisted by under-foremen and charge hands, as required. They must all be thorough foundrymen, and men of some culture and general education as well. They must be possessed of the temperament, tact, and firm judgment which go with leadership. On all these men rests a heavy burden of responsibility, for the rank and file have only limited intelligence and training. Accordingly, such men are well paid, and it is not uncommon for the general superintendent of an American foundry to draw a salary of £1,600 a year, with his chief lieutenants receiving from £700 to £1,200. Naturally there must be a large output over which to spread such a pay roll, and the strain on the leading men is correspondingly nerve-wracking and severe.

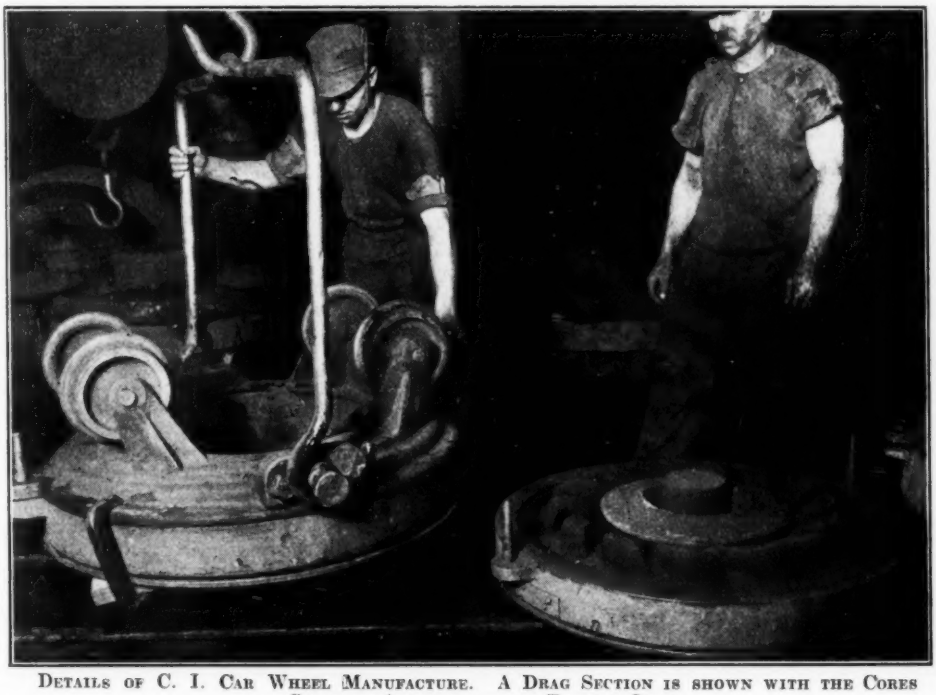
Some further detail regarding the production expected and attained under these conditions will now be presented, accompanied by an explanation of the methods adopted and results obtained, thus bringing the subject to its crux, which is to show with some definiteness the steps taken in large American foundries to control the quality of the product.

Where Quality Commences.

The control of quality in a foundry commences with the cupola or melting furnace, but since good metal is useless without good moulds into which to pour it, the latter will be considered first.

A most striking example of increased efficiency, accompanying increased production, was recently reported to the writer by M. A. Blakey, now foundry engineer for the International Harvester Company. In making automobile engines, the crank-case core is usually rammed up in two halves, which are subsequently pasted together. These cores must be very accurate, and it has been customary to rub down the joint of the core by hand to ensure a satisfactory casting. The production under these conditions was approximately 10 half-cores per man per hour. When at the Wilson Foundry and Machine Company, Mr. Blakey says, a machine was built to finish the joint between the two halves of this core by grinding. Two men with this equipment actually turned out regularly 125 half-cores per man per hour, compared with 10 by the preceding method. The hand-jointed cores varied from piece to piece by as much as 3/32 in., whilst the machine-made cores never varied more than 1/64 in. By hand, the quality of the product depended on the workman, whereas under the mechanical method it depended solely on the set-up of the machine, which had to be checked only at intervals of three or four days.

In another case, mentioned by Mr. Blakey, on the testing bench where the cylinder blocks for Buick cars were subjected to water pressure before delivery to the machine shop, men working by hand each tested 14 sets of cylinders per hour. The holes were closed with clamping pads and expanding plugs. After becoming worn, the plugs would occasionally blow out, drenching the operator, who, when not under the eyes of the foreman, became inclined to reduce the water pressure. This resulted in some leaky cylinder blocks finding their way into the machine shop, with



DETAILS OF C. I. CAR WHEEL MANUFACTURE. A DRAG SECTION IS SHOWN WITH THE CORES SET AND ANOTHER BEING TURNED OVER.

generally deleterious effects on the quality of the output of the foundry. Later, a semi-automatic test-rig was provided, which stopped all the holes securely and made it impossible for the operator to reduce the water pressure. This device was operated by one man, who was thus enabled to handle 75 cylinder sets per hour. Three men were released for other work, but, what was more important, the substitution of an accurate machine for human frailty not only speeded up production, but materially improved the general quality of the castings manufactured.

The importance of constantly studying details of shop procedure, in order to control and improve the quality of the product, was clearly brought out some little time ago by Joseph J. Wilson, plant manager of the General Motors Company, in an address before the National Founders' Association in New York. Speaking directly on the posibility of improving the quality of moulds, and consequently castings, by the adoption of mechanical methods in place of so-called skilled hand labour, Mr. Wilson said:—

"By studying the peculiarities of machine-rammed moulds, and then designing our flasks accordingly, we have been able to eliminate completely all gaggers from our production work. I will give an actual example. We received a job, patterns, flasks and machines, which had been running at an outside foundry for about two years, and is generally known as a bad job. The flasks

DETAILS OF CAST-IRON CAR WHEEL MANUFACTURE—A PATTERN IS SHOWN IN THE CHILLER. THE DOT ON THE PATTERN MUST CORRESPOND TO THE LINE ON THE CHILLER.

were good cast-iron flasks with machined joints, and the customary number of bars. It required 78 gaggers and 42 twentypenny spikes for each mould. We designed a new flask, which resulted in the elimination of all the gaggers and a reduction of the number of spikes and nails to eight for both the cope and drag. We also were able to discontinue tucking the bars. This made it possible for any labourer who can shovel sand to operate the machine and give us a perfect mould. What was considered a bad proposition had become a good job, with a loss of under 10 per cent. instead of the previous loss of 40 to 60 per cent. This is the only job on which we are using nails, although our work is all of a more or less intricate and irregular shape, and our sand has to be kept fairly weak in order to run our thin section work."

Getting the Right Sand

To operate successfully on the quantity-production basis, special attention must be given to the handling of materials, especially pig-iron and sand. Mr. Wilson points out that one crane operator and one labourer can unload 40 tons of pig-iron with a magnet in an average time of 45 min. This estimate takes into consideration transferring the metal a distance of 50 ft. To do the same work by hand would require at least 15 men. "A modern installation for mixing facing sand," says Mr. Wilson, "may vary from a plain power riddle to a combination of a riddle, a crusher, and a centrifugal machine. At the Central foundry the batch is made up in front of the riddle located on the floor level, the sand being shovelled into the riddle by hand. A short bucket elevator raises the sand from the riddle to the crushing mill, in which the mixture is thoroughly ground. Another short elevator raises it to the top of the centrifugal mixer, which discharges directly into bins below. The capacity of one of these units is 158 tons per nine hours of continuous operation. A crew of three men making up the batches and running the machinery intermittently can mix about 46 tons of facing per day." Core sand may be handled along similar lines. This system means that the sand is mixed at minimum expense per ton, with the added advantage that, given proper supervision, it is absolutely uniform from day to day, resulting in more satisfactory castings than where the moulders are allowed to mix their own sand, according to their own fancies or ideas.

Few foundrymen appreciate the weight of material handled in their shops per unit of output. A study of this question shows how necessary it is to give thought to the details of production. Along this line, Mr. Wilson said in the address already referred to, that at the Buick foundry it was found that it was necessary to handle over 64 tons of material for every ton of finished castings produced, in spite of the fact that the plant is laid out so that a continuous flow of materials is possible.

"In order to save floor space and flask equipment at the Central foundry," said Mr. Wilson, "the shop is run continuously— that is, the pouring starts at 7 o'clock in the morning, and the bottom is dropped at 4.30 p.m. After giving the matter considerable thought, it was decided to set the moulding machines in the middle of the floor, instead of at one side as is customary. The operators start in the morning on one side of the machines, and after placing about 24 moulds, varying with the size of the job, they move to the other side. Then, while they fill up this space, the moulds on the side first filled are poured and shaken out, and the sand is tempered and cut back to the machine with a travelling sand-cutter. By this method 120 to 140 moulds, each 24 × 36 in., of a four-cylinder block with the crank case attached can be moulded on a floor 24 × 60 ft. in a day. This same floor space will also produce 100 to 110 six-cylinder blocks, each of these floors requiring an equipment of only 40 flasks. For jobs such as crank-cases, requiring little core setting, which at the same time are quick cooling, a production of 200 to 225 moulds requires a floor space of 960 sq. ft. Six hundred and thirty 12 × 18 in. snap-moulds have been produced on a floor space of 480 sq. ft."

At the Ferro Machine & Foundry Company plant at Cleveland, with methods akin to those just described, but using continuous conveyors, as high as 58 good Chevrolet cylinder-castings an hour are being made.

These high-production methods are not confined to the motor-car industry, although it is in that field that they have reached their greatest development. For the new vehicular tunnels under the Hudson River 88,140 segment castings will be required, with an aggregate weight of 115,000 tons. Although made wholesale, these castings must conform to the most rigid specifications. The composition of the metal is as follows:—Si., 2.50 per cent.; S., under 0.05 per cent.; P., 1.00 per cent.; and Mn., 0.70 per cent. These castings are to be produced at the rate of 200 tons a day on large jolt-ram roll-over moulding machines using a large number of accurately fitted interchangeable flasks. The core-prints are attached permanently to the pattern, and the end-cores, which are of an odd size, are grouped on one large core; thus the chances for error are eliminated, and the cores can be set with perfect accuracy by unskilled labour.

Cast-Iron Car Wheels.

American railway truck wheels, which are of cast iron with a chilled tread, offer another example of a combination of rigid specifications and quantity production. Two hundred wheels a day may be regarded as the average output of a "car-wheel" foundry. This necessitates melting about 100 tons of iron a day and handling an immense tonnage of sand, flasks, etc. "In most modern car wheel foundries, the moulds are arranged in long, straight rows, each row being under a monorail hoist which serves to handle the flasks and molten iron. The moulder is relieved of virtually all

responsibility. He rams the sand, draws the pattern and sets the cores. He has to do no measuring; chaplets are supplied of the exact length, and are attached to permanent locations in the flask bars. Two men put up from 20 to 24 car wheels a day. The wheels weigh from 550 to 750 lbs. each. Their average life is about 60,000 miles. They must conform to the most rigid tests and specifications, since breakage might easily result in a disastrous wreck. In fact, only a fraction of a per cent. of these wheels break in service, although the loads are frequently 10 tons per wheel.

Machine Tool Foundries.

Foundries catering to the machine-tool trade must also meet closely-drawn specifications, and at the same time get out a large tonnage. In a foundry taken over by the Bullard Machine Tool Company, Bridgeport, Conn., the average daily output of castings per man was raised from 350 to 1,180 lbs. through the application of intensive production methods, coupled with a plan of paying wages which provides a bonus in addition to the hourly rates for increased production over specifications for medium castings call for a tensile strength of 9 tons per sq. in. and a transverse strength on the arbitration bar of 2,900 lbs. per sq. in. At the Bullard plant, however, the average tensile strength is 14½ tons and the transverse strength around 3,960 lbs.

Beds for 24-in. vertical turret lathes conforming to these specifications are now moulded in 14 hrs., as against 28 hrs. before machine equipment was installed. The bed for a 36-in. vertical turret lathe, which formerly took 32 to 34 hours to mould, is now turned out in 16 hrs., while a 42-in. bed, formerly taking 42 hrs., is now made in 24 to 26 hrs. The best time under the old system for the bed of a 61-in. boring mill was 56 hrs. This work is now accomplished in 32 hrs.

Where the Catch Comes.

Many are the devices which the progressive manager of an American quantity production foundry develops solely for the purpose of protecting the quality of his output. This gentleman is pictured in the minds of some people as spending his days and nights exclusively on contrivances

IN THIS FOUNDRY, A MAGNET SUSPENDED FROM THE CRANE IS EMPLOYED TO MAKE UP THE PIG-IRON CHARGES IN THE STEEL BUCKETS. EACH BUCKET HOLDS 10,000 LBS.

a predetermined standard. Quality standards cannot be maintained under any system of quantity production which does not provide good wages. In fact, in the most successful quantity production shops, where the highest grades of work are turned out, the men earn considerably more than they could obtain for similar work in most other shops. But since these high earnings are spread over an increased output, the wages per ton are usually less than the average. Thus in one Detroit shop girl coremakers are earning about £1 a day, but through supplying mechanical equipment, which reduced the maximum lift to 30 lbs. weight, the production was increased 25 to 75 per cent., and the core-making cost reduced as much as 50 per cent., despite the high wages.

At the Bullard foundry, mentioned above, the average output recently has not fallen under 1,020 lbs. of good castings per man per day, with a maximum in one week of 1,360 lbs. per day. This is on lathe beds, head stocks and other machine-tool castings. Tests have shown that owing to the use of proper equipment and careful supervision this rate of production has not brought about any deterioration in the quality of the castings, which conform to high standards.

The American Society for Testing Materials'

and schemes to squeeze a little more effort out of the workmen, or in urging an already over-taxed equipment to just a trifle higher speed in order that the precious tonnage chart may trend ever upward. Intriguing as this picture may be to the disciples of easy-going methods, it does not reflect the facts. The modern foundry manager really devotes most of his thought to problems relating to the quality of his product, and to meeting specifications, while at the same time keeping up a predetermined rate of production. Once the proper rigging is set up and put in motion, it is easy enough to turn out a thousand automobile cylinder blocks a day. If this is all that were required no high-priced foundry managers would be necessary. Where the catch comes is in turning out a thousand *first-class* cylinder blocks a day. It is for doing this that the foundry manager draws his high salary. The writer knows of one shop in Detroit where, as soon as each mould is made, a sheet of clean white note-paper is placed over the runner to prevent any small particles of dirt from being brushed into the cavity. Very likely the resulting castings would be just as good if this detail were omitted, but these clean sheets of paper serve to remind every man in the shop of the necessity for taking care. They symbolise the ideals of the

management, which are focussed not on merely out the work, but on getting it out *right*. And in working toward this end the psychological value of these sheets of paper is considerable. They aid definitely in getting out a better grade of castings.

But the struggle for quality in the foundry is handicapped by the fact that, in most directions, it is not possible to work objectively. The real worth of a casting depends in the last analysis on the hidden action of the melting furnace and on invisible elements in the metal mixture which determine the strength, elasticity and resistance to wear of the final product. Therefore, in a properly-run quantity-production shop the metallurgical department is of paramount importance. Results are what count, and results depend on the metal. Chemical control of melting practice, coupled with patient research into metallurgical mysteries, are almost invariably found in American foundries of the better sort.

Analysis at the Spout.

One foundry making soil pipes on a large scale is able to maintain high standards along with the production of 300 tons per day, according to George K. Elliott, of the Lukenheimer Company, Cincinnati, by having a chemical laboratory situated right at the cupolas analysing every ladle of iron individually, including determinations for carbon. This continuous analytical control makes it possible to detect immediately any tendency to diverge from the predetermined standards of quality, these divergencies being corrected before they have become serious.

(To be continued.)

Italian Iron and Steel Industry.

A Ministerial change that brought into power men of action gave new energy to the Italian iron and steel industry, and the shares of many of the works improved. A proposition was made in the Italian Parliament for transferring some of the railways to private companies, with a view of stopping some of the present abuses, and secret negotiations were opened with a small group of financial and industrial people.

Although other metals went back in price considerably, due to the improved foreign exchange, this was not the case with iron and steel, the prices of which changed very little during the month. After long negotiations with France, Italy made an agreement for a year, under which minimum tariffs were arranged on imports from both countries. This will undoubtedly favour the importation of coal, pig-iron and scrap from France, already facilitated by the improved exchange.

At the time of writing no decision has as yet been arrived at by the Government regarding the embargo to be placed on the export of scrap metals, and for this reason Italian works continued to suffer a certain scarcity of same, being thus less favourably situated than the German works, who continued to compete with them in their own market. The newly-formed firms of Ansaldo, Terni and Ilva, although still in the throes of consolidating their position, have been able to increase somewhat their production.

Some of the quotations on the Milan market at the end of November were as under, in Lire per metric ton (exchange rate about Lire 94.50 to the £ sterling): Black sheets (4 mm.), remained at 1,750 (£18 10s.); galvanised sheets (No. 20), remained at 2,950 (£31 4s.); black wire remained at 2,050 (£21 14s.); rods remained at 1,500 (£15 16s.); cast-iron pipes remained at 1,950 (£20 13s.); boiler tubes remained at 3,500 (£37 1s.); Italian welded tubes remained at 2,900 (£30 14s.); Italian seamless tubes remained at 3,100 (£32 16s.); Italian galvanised tubes rose from 3,750 to 3,800 (£40 4s.); railway rails fell from 1,350 to 1,300 (£13 15s.).

WM. OLSEN, LIMITED, inform us that they have removed their office recently from 74, Cogan Street, to the corner of Cogan Street and Spruce Street, Hull. The premises at 74 are now used only for stores, and correspondence should in future be addressed to William Olsen, Limited, Cogan Street, Hull.

THE TURBINE FURNACE COMPANY, LIMITED, received eleven orders during last month for their patent furnace to be fitted to various types of boilers. Many were repeat orders, including those from Richard Thomas & Company, Limited, the South Metropolitan Gas Company, and the Hughes Stubbs Metal Company.

The Arbed Group.

The annual meeting of the Aciéries Réunies de Burbach-Eich-Dudelange (Arbed) was held on November 25 in the new premises in Luxemburg, when the report and accounts for 1921-22 were received and approved.

The report states that the crisis referred to in the previous report particularly affected the early months of the past financial year, and the improvement which subsequently set in was very slow. It was due mainly to a considerable increase in the output, which it had been found possible to dispose of without difficulty, thanks to the Company's commercial organisation on the one hand, and their investments in foreign industrial undertakings on the other hand, which absorbed increasing quantities of the Arbed's products. At present the situation could be regarded as comparatively satisfactory. Future development would depend essentially on political events and the solving of the problem of reparations. During the year no special difficulties were experienced in obtaining fuel supplies, so that it was possible to increase the output and earn nearly the same profits as in 1920-21. After referring to the burdens imposed by the legislation of the Grand Duchy and to the freedom from labour troubles during the year, the report states that the Company had decided to allocate to the social welfare fund the sum of 4,500,000 fcs., being the same amount as in 1920-21.

The Comptoir Métallurgique Luxembourgeois (Columeta), which was established two years ago in conjunction with the Société Métallurgique des Terres Rouges for the sale of their products, continued to give complete satisfaction. Since the preceding year new branches of the Columeta had been established at Antwerp, Stuttgart, Sofia, Shanghai, Hong Kong and Tientsin. Concerning the associated undertaking just referred to—the Terres Rouges—the report mentions that the second year of the latter, as had been fully expected, turned out less favourable than the first year. Nevertheless the situation was markedly better than in 1920-1, particularly in regard to the Luxemburg branch at Belval. The report refers also briefly to other undertakings in which a financial interest is held by the Arbed, and then proceeds to give figures of the Company's production in 1921-22.

The output of the iron mines amounted to 1,748,000 tons (1,575,000 tons in 1920-21); the coke output at Burbach was 297,000 tons (204,000 tons); of pig-iron, 730,000 tons (482,000 tons); of basic and open-hearth steel ingots, 735,000 tons (498,000 tons); of electric steel, 219 tons (299 tons); and of rolled products, 621,000 tons (416,000 tons). In addition, the shops producing structural work turned out 6,621 tons, as against 3,487 tons in the previous year. The total number of workmen employed by the concern was 14,461, and the officials numbered a further 768.

The gross profits amount to 28,152,000 fcs., as compared with 30,253,000 fcs. in 1920-21. After writing off 8,219,000 fcs. for depreciation and appropriating 4,500,000 fcs. for welfare purposes, the accounts show net profits amounting to 15,432,000 fcs., and the proposed dividend is at the rate of 120 fcs. per share, as in 1920-21.

Grangesberg Company's Shipments of Ore.—Shipments of iron ore by the Grängesberg Company during the first ten months of the current year amounted to 3,979,000 tons, as compared with 2,995,000 tons for the same period in 1921.

Forges et Aciéries du Nord et de l'Est.—This French concern reports for 1921-22 net profits amounting to 690,936 fcs., which, added to the sum brought forward from the previous year amounts to 1,986,125 fcs. (say £33,100) which is to be carried forward to next year's account.

Forges et Aciéries de la Marine et d'Homecourt.—This French concern reports for the financial year 1921-22 net profits amounting to 3,693,521 fcs. (say £61,560). The dividend is to be 30 fcs. per 500-fc. share, as against 40 fcs. in the previous year, on a share capital of 70,000,000 fcs. in both years. The Board suggests an increase in the share capital.

Dry Sand Moulding for Small Work.*

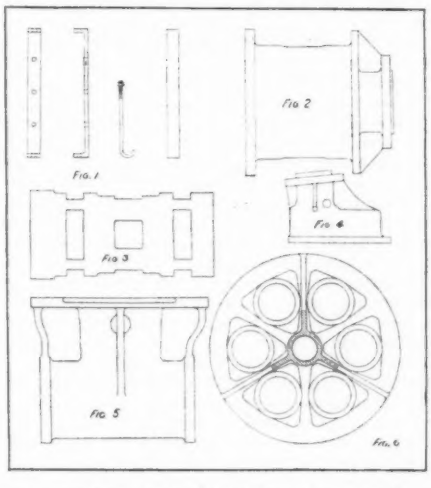
By J. D. Nicholson, A.I.Brit.F.

Small work in dry sand moulds is generally regarded as the simplest of the various classes into which the founding of castings is divided, and is distinctly a class by itself. Like its companion class, green sand, the same amount of care is needed, and although the sand ingredients are somewhat similar they are compounded and used in an entirely different manner.

Dry sand being glutinous, earthy and highly refractory—entirely opposite to the quality required for green-sand—it must be worked with a certain degree of dampness to bring that cohesiveness, plasticity and pile which it readily gives.

Heavy and large castings are moulded on different lines from small castings. A small-work moulder would very readily adapt himself to the methods and conditions of making large castings, but when reversed results satisfactory to the employer are very seldom obtained. It takes a man a long time to master this class of work, and it is only by being alert to the circumstances, and the use of commonsense that he is able to find out the methods of moulding intricate and troublesome parts, and also to remedy any little fault in the patterns, as well as in the castings.

Over-confidence in the strength of the sand or omitting an iron during ramming may mean a few



hours' anxiety during finishing the mould, and even the result will not be certain until the dressers have finished with the casting. A joint may be made correctly to suit the pattern, and yet be wrong in regard to fitting the cores in the mould. The leaving-in of a screw in large patterns—sometimes the impression is received that the patternmaker does his best to hide important screws—can be remedied by the application of weight and pressure, but not so in small work, where this fault may be the reason for the mould having to be made over again. The gathering together and working with several odd part boxes calls for careful manipulation, as also does the placing of runners and risers, and making passages for core-vents.

A moulder should have a knowledge of the various types of machinery which his firm builds. He then knows which is the important part of his casting, what part *must* be sound, and also where to allow for machining instead of continually referring to his foreman, as every pattern is not marked as to where the casting has to be machined. He would know where the placing of a chaplet would be detrimental to the casting, and why the pattern had been made in such a way. He should be able to see all his requirements from deciding upon the boxes to be used, to the position of the weight for casting.

The moulder might also pay attention to the manner the cores are being made. A good mould is as essential to a good casting as a good iron. Cleanliness, individuality and speed, combined with care, are qualities which a small-work moulder must possess.

The castings made by the dry-sand method are usually those of intricate design which would entail a certain amount of risk if made in green sand; outstanding amongst these are castings which have to be scrupulously clean when machined and others having to withstand a high steam- or water-test.

Boxes and Bars.

Owing to the continual change of designs in various branches of engineering and regular slight additions to patterns, it is very desirable that boxes should be available which can take loose bars. A good supply of boxes of several different sizes should be at hand, as well as an ample quantity of loose bars. Each box should have numerous holes in its side to allow for bars being inserted, and also a few, about 2 in. dia., to assist drying and also for passages for core vents. Fig. 1 illustrates typical bars. A supply of hook bolts, up to 16 in. long, are very handy as box bars. In such places as where two pieces of pattern are near each other, say about 2 or 3 in. apart, it would be impossible to fix an ordinary bar, and some moulders would have recourse to laying long irons over this part, which have no definite hold save the binding of the sand. If, however, hook bolts are passed under, and screwed up, they answer the purpose with good effect. For instance, underneath the flange of a branch in a top part, a good workman would foresee it and move his box to suit. In all cases, where bars suitable for bolting are not to be had, bolts of this description are far more easily inserted and safer as compared to the proverbial wedging in of loose bars. This wedging-in, especially if two or three bars have to be inserted, often takes up much time, besides causing annoyance, but still it is a fairly simple and quick matter if the hammer is used with intelligence. There is no strain on the box when bolted, bars or long bolts are used, whereas the wedging-in of bars often fully extends the box side, resulting in the box being broken during the operation of removing the casting—the least tap with a hammer on the side of the warm box being sufficient. Of course, wooden bars can be adapted in dry-sand moulding, but they must be used with discretion, and in a top part the sand must be stayed-down previous to casting.

In making a mould, there are often doubts as to whether it should be moulded in the floor or in boxes to be dried in a stove. Even if it were only for the comfort of the employees, the latter method should be used whenever possible, and perhaps also it would show a saving in the coke bill.

Turnover Moulding Preferable.

Wherever it is practicable, in small work, patterns should be turned over instead of bedding in the floor. It would materially lengthen the life of the pattern, as it would suffer less from heavy impacts. The moulder would see better in place of working "blind," as sometimes occurs when moulding in the floor.

In digging a hole in the floor to mould a pattern, it is the custom to sprinkle water over the hole. Sometimes a great deal is used to soften the sand, so that the new sand will adhere to the old, and if a casting has been previously in the hole, it is *flooded* with water. Of course, it soaks in, but it is increasing abundantly the water to be driven off by the fire. When the fire is taken away from the mould previous to closing, and as there are no exits for the steam in the sand, the vapour gradually finds its way to the face of the mould. The tackle necessary for the top part to sit upon over the fire during drying is not always found at hand, and often entails some manual labour.

Economies from Proper Venting.

When ramming up a mould in boxes which are to be stove-dried, everything possible should be done to encourage satisfactory drying. If a few

* A Paper presented to the Newcastle Branch of the Institution of British Foundrymen.

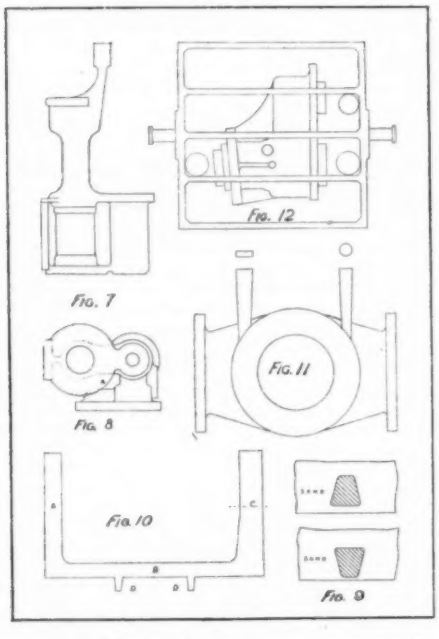
fine ashes are inserted, making a vent passage from an awkward part during ramming up, and several vent-wire holes, about ¾ in. dia., reaching well to the pattern after having rammed it, their effect on the mould and casting is very marked. These factors are continually working in aid of the mould and casting from the time of its entry into the stove until it is full of iron and the iron has set. They provide a sharp outlet for the steam from the sand during stoving; they give an easy exit for the steam which is gathering while it is standing after having left the stove; and, lastly, they facilitate the departure of steam and gases formed during the process of casting.

When a mould is finished the boxes can be removed to the stove or elsewhere and the floor space used for something else, but if the mould is in the ground the space is occupied until the mould is cast.

If the bars in a bottom-box are reliable, it should sit on bricks and not on a sand bed. The latter chokes up the pricker holes, besides allowing the warm mould to draw dampness away from the wet sand.

Economies from Limiting Wetting Sand.

The mixing of old sand is often done in a haphazard manner. Many assume, as it has to be dried, it is not necessary to be careful with the water, but in reality the sand only needs to be sufficiently damp so that it will unite readily when



rammed, and by having no excess the moulder is helping the drying of the mould.

Hard and Sound Ramming.

In the operation of ramming a mould the idea is prevalent that dry sand requires to be rammed very hard, whereas *sound* ramming is all that is required, although where straight depths are encountered they have to be made very sound, as any soft places would result in swellings on the castings, caused by the pressure of the iron on the mould. Where hard-ramming has been indulged in, the pattern does not "give" readily to the process of rapping; consequently, when withdrawing the pattern, joint edges suffer damage as well as the mould. Of course, the pattern is blamed for having no taper, but frequently it is the moulder himself who is at fault. The difference between the pressure of ramming *hard* and the pressure of ramming *sound* can only be determined at present by practical experience. In a hard-rammed mould the grains of sand are packed so closely together and are so compact that the gases and steam generated by the hot metal have no easy way of escape through the sand, and therefore return and cause small holes so often to be found in the casting.

Pinholes.

The moulder should consider what takes place while the mould is full of iron. The metal on the mould face solidifies first, and that against the core setting next. Therefore any air or gas-bubbles in the iron will rest in that part of the iron which is molten longest, and that part is nearer the core than the mould face. This, the author believes to be the reason why these small pinholes are mostly found under the skin of the inside of the casting. This fault is more common with castings that have been moulded in the floor.

After the hole has been dug in the floor and new sand put in, the pattern is placed, knocked down to the required height, and levelled. It takes a great deal of force to get the desired effect, and consequently the lowest part of the pattern is making the sand at that part very compact, and, when the pattern is withdrawn, it is found to be exceedingly hard. No notice is taken of this, but probably the sand is ruined so far as any porosity or venting qualities are concerned.

Small holes are often found in castings where the bore requires to be machined, such as castings for balance cylinder-bodies, piston valve-liners, boiler stop-valves and main engine stop-valves (Figs. 2, 3, 4 and 5). Several of this class of castings have been made both in the floor and in boxes, but the author has not encountered a casting with this fault when the mould has been dried in the stove. Of course, moulds of this kind should not be cast with iron at a low temperature, but if dull iron happens to be available the stoved-mould has the greater chance of giving a sound casting if rammed up as indicated.

Engine Stop-Valve Castings.

In moulding an engine stop-valve (Fig. 5), two large brackets are encountered, and any gathering of steam on these will result in their scabbing. Suppose that the bottom half is being rammed up on a turnover board. After the outside has been rammed a few inches sand and irons are inserted in these brackets. Having received about 4 in. of ramming, they should be treated similarly to making a core. A hole is made in the centre to about 2 in. of the pattern, from which small vent-wire holes are made to the fillets of the brackets. A handful of fine ashes is inserted, and a gate stick or narrow tube is made to protrude above the box. The box is then rammed up, and this stick or tube withdrawn.

The regular routine is then performed and the top box placed on. Although the rule in stoved work should be to facilitate drying, numerous workmen are noticed putting wet loam on the joint for the top part. A loam joint is satisfactory where a mould is being made in the floor and has to withstand the heat from the fire, but ordinary dry sand is all that is necessary when the mould is going into the stove. The large brackets have again to be dealt with, and here, as in all cases where brackets, pockets and awkward places are encountered, they should be damped and dusted with parting sand. Whilst the use of loam is not desirable in places like these, however, loam mixed with new dry-sand until "stiffish" placed on these parts and the grate bedded on, makes the pattern withdraw excellently. The remainder of the top is rammed up, but no stick or tube need be used on the brackets, as a few thick vent-wire holes reaching well to the pattern from the top of the box answers the purpose.

This mixing of loam with dry sand ensures a good draw with the pattern in moulding a circulating pump head-valve, owing to the numerous thin facing-pieces, such a pattern possesses, as shown in Fig. 6.

Reversing Engine Cylinder Bodies.

In moulding a reversing engine cylinder-body (Fig. 7) a difficult part is encountered between the barrel and the chest, marked A in the end view (Fig. 8). It is about 8 in. long, with a depth of 4 in. in the chest, and about 2 in. of sand between the barrel and the chest flange.

Care must be taken in laying the irons to hold this part. They must be placed soundly and free from any tendency to spring, which is only found when the pattern has been withdrawn, and which, when it occurs, needs careful attention. It must also be rammed sound, and the irons must not be

hit with the rammer. If this occurs it may loosen a part of the mould face, which may not be seen when finishing, the probability being that it will lift off when the molten metal reaches it.

The coring-up of such moulds requires care in handling the femmer cores, but the advent of the oil-sand core relieves the moulder of a great deal of the skill and precaution he had to use, not only in handling the cores, but in bringing off the vents and keeping them clear.

This mould can either be cast in a horizontal or vertical position, and sound castings can be made both ways. The vertical position entails clamping or bolting the boxes together and turning on end. In the other position, the piece of mould between the barrel and chest causes trouble if care is not taken. The iron fills the chest first, and causes steam and gases to rush through this piece, and if not brought away, scabs will be frequent on this part of the mould. To prevent the trouble, a narrow vent is made through it and brought away through holes in the sides of the box. There is very little room to make it, and care must be taken, or the iron will break into the vent itself.

Whenever the use of grates is undertaken, they should be made as light as possible, but strong, and placed so as not to interfere with the contraction of the casting. It may be observed that quite often a moulder walks a considerable distance in search of a pair of wire twisters when a simple twist of the wire provides one. Fig. 9 shows two views of a section of a grate in the sand.

A grate has a broad side and a narrow round side, and many use the broad side downmost, their reason being that it has a better hold of the sand, in that the broadest part is nearest the joint. With the narrow side down, it is an inch from the joint, but then the sand round the grate is all bound together, but in the other case there is nothing supporting the sand under the broad side except the claywash on the grate. That this is so a moulder finds out when, after turning over the top part, after finishing, he ascertains if all is well, and finds the joint has given way. The jerking of turning over, although sometimes only slight, may be sufficient to cause this lower piece to fall away and perhaps bring an awkward part along with it. This fault is more applicable to green-sand moulding, although it sometimes occurs in dry sand when the mould is roughly handled when charging the drying stove.

Dropped joints are also caused by grates being put on when they have not been hanging level on the wires, but whatever way a moulder uses his grates on the joint of a mould, under no circumstances should a grate be bedded flat-side down on what will become the face of the mould, as, for instance, on brackets of flanges. If this be done in either green- or dry-sand, a scab will very often be found on the casting at that part. The reason is partly explained in the case of the joint grate, but here there is the sand under the flat-side completely absorbing all the claywash on that piece of the grate. The layer of sand, being very thin and overburdened with clay, "gives" from the grate during drying. This is not noticeable during closing a mould, but when the molten iron reaches it, it peels off the grate.

If any dampness be on such places, the steam caused by the molten metal strikes back from the grate and forces the sand away. This happens more especially in green-sand, owing to the dampness of the sand, but the use of the oil-pot sometimes acts as a safeguard. When lifters are used, a good moulder never uses any made of flat iron, round iron always having his preference.

A small-work moulder has to rig together all kinds of boxes and odd sizes, and sometimes a set of boxes, complete with pins for guiding, is at hand to suit a pattern; but very often such kinds of boxes are found wanting, besides being unsuitable. When this is so, guides have to be made accordingly. Various devices are used for this, such as cramping small angle-bars to lugs on the boxes, scratching marks on the boxes, and making loam guides. The use of angle bars is handy when the top part is overlapping the bottom part, and, where lugs are available, on the bottom for cramping the angle bars.

Where box parts are exactly the same size, and there is no overlapping, marks can be scratched on the box sides with the trowel and straight edge. These can be used several times, as they remain on the boxes a long time; but whether boxes have a good or bad fit, the general view is that only one kind of guide can be used, and the loam guide is used extensively. Although at times it is the only one that can be used, it suffers damage very easily, and often, when closing the mould, very little remains as a guide at the final operation.

Loam greased on the box side, where claywater has been applied, should be sleeked with the trowel until it is less than a ½ in. thick, cut at the joint, and again slightly sleeked over. Three or four marks are usually injudiciously made with the edge of the trowel, but if three marks are made with the trowel carefully and widened out to a V-shape, they will be found to stand longer than the former, whilst being more visible, besides looking more workmanlike.

In finishing a mould cleanliness and tidiness are important. All loose pieces of mould should be pulled away, claywash applied, and made up sound, sprigs or brads being added if necessary. Loose pieces of joint should be saved, clay-watered and replaced in position. All joint edges should be made good first, core prints attended to, then the mould proper. Fillets, especially on brackets and flanges, ought to be finished with the fillet tool and not sleeked flat with trowel, as is generally done.

Flat and horizontal surfaces are more liable to scabs, while on round parts they are seldom seen. A good-sized fillet is very desirable, as at these places the thickness between the core and the mould is generally fairly thin.

Water is sometimes used to excess during finishing. In some cases the mould is washed over with a brush before black-washing. The excessive use of water causes the numerous cracks which are found in the mould on its return from the drying stove. They look unsightly, although very seldom causing any trouble, but the stability of the mould sometimes has one in a quandary until the casting is seen.

The placing and cutting of runners is an important matter, and they are very often made with the least care and thought. In castings where freedom from dirt is essential, a good type of runner is shown in Fig. 10. The iron drops down A and runs along B, which is cut in the top part. Any dirt or scum passing down A tends to rise to the top side of B and pass along into C. C should be wider than A, in order that any scum gathering shall not jam itself at the bottom and so prevent the gathering of more, which, if prevented, would remain in B and perhaps enter the mould. D are runners into the mould, and if more than one is cut, B must be increased in volume accordingly. On no account ought the mould to take the iron quicker than will allow B to be kept full. The runners D should be cut as far away from A and C as is judicious, and so ensure the cleanest of iron entering the mould. C need not be made the full height of the box. If made half way, it will save the making up of a riser. It is customary to cut a runner into the mould so that it will reach the lowest part first, but it is not always good policy to do so. For instance, the boiler stop valve (Fig. 4), although possessing a large, thick flange, it is not advisable to use it for the iron to enter. This part of the casting is the most important, being subjected to a continual steam pressure, as it is bolted to the boiler, and any dirt lodging here would be detrimental to the strength of the casting. It is advisable to avoid cutting a runner into a machined part of a casting, as scum generally remains in the boil of the metal, which in such cases would show itself during machining. Sometimes it happens that a mould is best run on top of a flange or on top of the mould itself, owing to the box available not allowing for adequate runner-room. In such cases a flat gate-pin is resorted to, but usually when the gate is broken off the casting several small holes are to be seen. With such cases it is advisable to use the usual round pin if it is possible, as seen in Fig. 12. It is satisfactory, and ensures the freedom from these holes which sometimes enter deeply into the casting. The cause of this may be through gas or air bubbles remaining in the boil of the iron, or the placing of the iron ball in a round gate, keeping back what would

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have otherwise passed down the flat gate. If any bubbling of the iron in the mould takes place, a round gate can be worked effectively with a feeding rod, while the chances are negligible in the flat. Risers are generally brought off from the highest part of the casting. They ought to be of good diameter, and not confined the full length to the diameter on the casting.

It is sometimes imagined that where a mould has received too much glaze during finishing this glaze affects the adhesiveness of the blacking. Of course, blacking must not be simply applied to the mould and allowed to soak in. It must be brushed backwards and forwards two or three times in order to knit itself with the pile. If it is not brushed in, it is easily brushed or blown off during closing the mould. If a mould be blacked evenly, and with thin blacking, there is no further need for the use of tools other than squaring up flanges and deep brackets.

When places are met with which are not easily accessible for blackening during the ramming up of the mould, coal-dust should be added to the sand for this part, and the skin of the casting will be found to be clean without blacking. As a further precaution, water-blacking is all that is necessary.

When castings have to withstand high-pressure, the double chaplet should be avoided as much as possible. The ordinary stalk chaplet stayed from the weight is as handy and serviceable as any for small work. Where the usual chaplet-nails are used, much trouble can be avoided, when closing the mould, if a nail is inserted in the various places, to about the required thickness, and withdrawn when the mould is green.

For castings which have not much thickness the chaplet-nail can be dispensed with for supporting cores, and joiners' nails, of soft material, used. The nail of tough steel is not desirable; the molten iron having little effect on the hard nail, and thus promoting the leakages which appear at these places.

The making up and working of vents from cores cause a little trouble at times. They are usually made up nearly flush with the edge of the box with a little taper. Sometimes they are made up too far, and sometimes they are displaced by a slight swing of the top box. If, during the ramming up of the top part, tubes are inserted behind each print and removed when rammed up, leaving holes sufficiently large for the hand to enter, vents will be able to be made up very easily. If it is not possible for a hole about 4 in. dia. to be made, a narrow hole, the width of the print, could be cut out when finishing the mould. When the top box has been lowered for the last time, a full view of the vents can be seen, and there is no necessity for trusting to chance. Narrow tubes can be put in these holes to connect the vent and sand rammed in at will. There is no fear of the iron reaching the vent from over the prints in this manner. It is far better to allow a vent to come away vertically or horizontally than to make it force itself downwards. In conclusion, the author wishes to thank his employers, the North-Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne, for permission to give this Paper, also their laboratory for assistance in producing slides, etc.

Catalogues Received.

JOHN G. STEIN & COMPANY, LIMITED, Bonnybridge, Scotland.—A new edition of their well-known red bound catalogue which foundrymen will find of technical value when designing new metallurgical plant, as it outlines standard sizes and the incorporation of such, lowers construction and maintenance costs. It is interesting to note that French, German, Italian, Spanish and Russian editions are also available.

MR. R. A. MILES, a prominent member of the Lancashire Branch of the Institution of British Foundrymen, has been appointed representative of the Stanton Iron Company for the Manchester district. His offices are situated at Grosvenor Chambers, 24, Deansgate, Manchester.

Influence of Temperature and Fatigue on Accident Rates.

In Report No. 19 (General Series No. 7, just issued) of the Medical Research Council of the Industrial Fatigue Research Board, some further light is thrown on the subjective aspect of accident causation, and in particular on the parts played respectively by speed of production, psychical state of the worker, and fatigue.

According to the Summary to Part A of the Report dealing with "The Influence of Temperature and Other Conditions on the Frequency of Industrial Accidents," by ETHEL E. OSBORNE and DR. H. M. VERNON, the number of accidents (cuts) experienced by the workers at three munition factories was found to be greatly influenced by temperature. This was registered continuously by thermographs for nine to twelve months at a projectile factory and a 6-in. shell factory, and it was found that the accidents at the shell factory agreed with those previously observed at a fuse factory in reaching a minimum of 67 deg. Fah. At the projectile factory the minimum was at 72 deg., but the combined results gave 67 deg. as the minimum. With fall of temperature the accidents increased gradually, and to a similar extent in the case of men and women, till at 52 deg. they were 35 per cent. more numerous. At temperatures above 72 deg. they increased very rapidly in men, but only to a small extent in women.

The hourly incidence of accidents experienced by the day shift at the projectile factory showed a qualitative resemblance to the output variations. They were low at first, rose to a maximum in the middle of the shift, and then fell away. The night-shift accidents, on the other hand, showed no resemblance whatever to output, except during the last two hours. They were at a maximum during the first hour, then fell off sharply, and finally sank to less than half their original number. Probably this incidence was largely psychical in origin.

The influence of fatigue in causing accidents was shown at the 6-in. shell factory. When the women worked the same 61 hour week as the men, their accidents were 91 per cent. as numerous, but when their hours were reduced to 39½ a week (those of the men being unchanged), their accidents fell to 78 per cent. of those experienced by the men.

In the Summary and Conclusion of Part B, "On the Relation of Fatigue and Accuracy to Speed and Duration of Work," by MR. B. MUSCIO, data are given showing that (1) an increase in rate of movement (for certain rates used) causes an increase in the inaccuracy of movement, and that the faster the rate in operation at any time, the greater in general is the increase in inaccuracy produced by any unit increase in rate; (2) continuous work for several hours (in one case for 3½ hours) with tests of motor precision fails to show any gradual increase in inaccuracy but the very reverse, the resulting inaccuracy curve being almost the exact opposite of the typical industrial accident curve for the morning hours; (3) a curve for inaccuracy of movement, broadly similar to the typical industrial accident curve for the morning hours, can be experimentally obtained by gradually increasing the rate of movement in a morning period of continuous work with motor precision tests.

In view of what is known concerning hourly variations in speed of production, the conclusion suggested by these results is that the principal factor in the hourly variations in the number of industrial accidents is not "fatigue," but rate of work.

ASSOCIATED BRITISH MACHINE TOOL MAKERS, LIMITED, have removed their Sheffield branch from Bank Buildings, 63, Blonk Street, to 4, Summerfield, Broomhill.

THE IMPORTS of foreign iron ore at the Senhouse dock, Maryport, during last month amounted to 3,000 tons, compared with 3,500 tons for October. There were no imports of ore at the corresponding period of last year. The imports last week amounted to 3,500 tons.

Gating, Feeding and Casting.

By E. Longden, A.M.I.Brit.F.

(*Continued from p.* 472.)

Castings have been saved, when likely to be lost due to an insufficiency of hot feeding metal, by throwing sulphur into the congealing metal. Iron sulphide lowers the melting temperature. This is, however, a dubious procedure, as one would have little faith in the metal about and under the riser. In the case of a casting requiring metal of any description, it might succeed.

The author does not agree that castings cannot be fed with the rod beyond locally; for example, a flywheel of about 10 tons fed by one riser on the rim, the boss being used as the section through which to pour the casting. The metal is very hot here, but is not fed, except by the movement in the metal created by the use of the rod in the riser.

In the case of large moulds, the setting of the metal can be felt by the rod meeting solidifying metal getting nearer and nearer. The metal cools from bottom, then sides, and lastly the top-middle portions.

Under and Over Feeding.

One can underfeed and overfeed. Many cases have come to light of castings being quite spoilt by overfeeding. Overfeeding destroys the structure of the metal, which might exhibit itself in very open grain, with gases entrained or in a distinct cavity. It can be tested by feeding rapidly for a prolonged time, and the metal can be reduced to fine particles made up of small groups of oxidised and injured crystals. The damage to the crystals is clearly noticed in the banded structure of almost any gate which has been fed over a lengthy period. Underfeeding is too evident to remark upon to any length. It is much better to remove what was intended to be a feeding riser if no real attempt is made to feed properly. In some cases cores help to feed a job.

Open or Closed Risers.

When employing drop-runners, the force or impact of the metal when it strikes the bottom side of the mould is almost like a hammer blow. With a closed riser the cutting effect is not quite so violent, because the air in the mould is somewhat compressed. This compressed air may save the scabbing and drawing in of the top part by preventing the surface gases from penetrating the mould cavity. Some amount of protection is also given to the top part by the lack of heat conductivity of gases. Compressed air may prevent the complete filling of the mould. In thin moulds made of loam and dry-sand, it is advisable to leave risers open. The metal will rise more freely. This is also true when pouring with stiff and sluggish iron. Quite a large number of wasters are caused through collected and trapped gases. If the mould has been burnt, it is advisable to keep the riser closed.

Flywheel and other heavy casting moulds should have closed risers. In the case of a flywheel, even the air at the joint ought to be excluded. Loam tops of large area will draw-in when using an open riser.

If a large mould be run short or the runners become clogged, a drawn-in top is likely to result if the risers are open. It is analogous to the drawing-in of a mould when placed to dry over a too-hot fire, although this may be due to a faultily-constructed mould.

With open risers, a strong current of gas will be noticed. Large volumes of gases are formed in the moulds generated from the sand materials and metal. These gases expand greatly, due to heat radiation, so that if the riser be kept open, the tendency will be for the gases to strike into the mould, to be expelled through the riser instead of by the properly-constructed vent channels. Risers which in Lancashire are termed French risers are put on simply to allow a free filling of a narrow part of a mould which would otherwise be run short due to gas pressure.

Head-Metal.

Head metal is an addition to the height of the mould to receive scum and to provide metal for feeding. Extra height in the head will help to feed, even through thin sections, and also to expel gases.

A lack of head-pressure would be especially noticeable if the metal be sluggish. When the metal freezes too quickly, the ferro-static pressure is relieved. This can be seen very plainly if one examines the bottom portion of the runner-gate adjoining the casting. There one will see at the juncture blow holes. The iron below has simply relieved itself of surplus gases, which are trapped in the hot spot in front of the runner.

The head or height of a column of molten iron makes only a small difference in the specific gravity of metal, but in the author's opinion it makes a great difference in the aid to the vents. With plenty of head-pressure, the vents are more easily persuaded to fulfil their proper function. The author's earliest recollection of a case where the provision of a good head-pressure meant success occurred during the latter part of his apprenticeship at a Manchester firm. At this particular firm they were making motor-car engines. In casting the cylinders they thought themselves lucky if they secured one good casting out of three cast. So soon as the metal appeared in the riser bush, they would blow. They tried to secure better results by constructing a run-off riser, actually reducing head-pressure. Noting this, the author hinted to the foreman that instead of running off, they might secure better results if they increased the depth of runner and riser basins. They were increased, and no further wasters resulted from that special reason.

Runner Basins.

Much carelessness is often noticed in the construction of runner basins. When pouring, little can be done. Months of work may be spoiled due to a little neglect. In making up a green-sand basin for medium and heavy work, it is advisable to ram the runner-box completely with sand, and then cut out to the desired shape. If much metal is to be poured, a piece of core or loam cake should be bedded in the dished-out place where the metal is first poured.

In heavy work the runner basin is often made up in loam or dry-sand, and stoved the night previous to casting. Wherever the basin cannot be constructed conveniently apart from the mould, it is made and dried in position.

Whenever the runner basin protrudes over the area of the mould, much care is needed in conducting the gases away from underneath the bush. The reason for this is obvious. Whilst pouring, gases are generated, and rise through the mould directly underneath the runner basin; add to this the gases from the material of which the runner basin is constructed, and there is a very formidable danger. Whether the basin is dried or not, means of conducting away the gases must be employed. Wisps of straw, wire holes and cinders are used for this purpose. In spite of such precautions when making large moulds, it is not unusual to find the bottom of the runner basin break and blow up immediately the mould has filled and the pressure released by the lower head of a run-off riser. Although the casting may then be safe, it is highly dangerous to the men engaged upon the cast.

Quite often a moulder is astonished at his good fortune, the morning following a previous night's blow-up, at securing a good casting. The blowing had not effected the casting. It was simply a case of the gases rising from the mould through the runner basin and metal. When pouring heavy castings it is advisable, wherever possible, to construct the runner basin outside the mould.

In much work precautions are necessary, when

XUM

pouring, to exclude the dirt and scum which collects and accompanies the first metal poured. Stoppers are placed over the down-runners and lifted immediately the basin is full, thus enabling the metal to gather its scum on its surface.

It is astonishing how little attention is paid to the correct forming of the mouth of the down-runner. Quite experienced moulders exist who will draw a gate-peg, leaving a proud, sharp edge to be broken by a flat stopper or scoured and washed away by the metal. The detached sand may enter the mould. In special work it is advisable to form the mouth of the down-runner in a core, so that a ball stopper can be employed. A piece of tin is sometimes placed over the gate entrance, which gives the caster just enough time to flush the basin full before it is melted.

Gating and Feeding Other Metals.

Correct gating and feeding of malleable iron and steel is much more important than in producing grey iron. Sometimes, reluctantly, a useful design of casting is rejected when the gating or feeding is at fault. The considerations are:—How can the castings be poured cleanly without a mis-run? Must feeding be done by way of runner or riser gates? In either case the proportion, location and area must be so that the weight of metal feeds down into casting. Funnel-like cavities in feeding heads show that good work has been done. When pouring light malleable iron, the metal is almost thrown into the mould by a twist of the wrist controlling the pouring. Many of the precautions taken to produce sound malleable and steel castings are used in the production of non-ferrous castings.

In the case of aluminium, good results are obtained by splitting and increasing the number of in-gates in a similar way to running iron. In-gates are sometimes placed entirely around the whole casting. Down-gates are made larger than in the case of brass and gun-metal.

Aluminium requires to be poured quickly. To depend on force of gravity would not be sufficient. As is the case when pouring light malleable iron, the metal is pitched into a large down-runner.

(To be continued.)

German Iron and Steel Industry.

The Iron and Steel Ware Industrial Union announces that the Export Tax Committee of the Economic Parliament has suggested to the Ministry for Economic Affairs that the export tax on all products coming within the competency of the Foreign Trade Bureau for iron and steel ware should be reduced to 2 per cent.

The German-Russian Trading Company, the proposed constitution of which was reported in this column a few weeks ago, is now being formed in Berlin under German laws, and with a share capital of 350,000,000 marks. One-half of this sum is being provided in cash by the Soviet Trading Delegation in Berlin and the other half by the group composed of the firm of Otto Wolff, the Phœnix Steel Company, Rhenish Steel Works Company, and the Zypen and Wissen Steel Works Company.

The Westerwald (Hachenburg) Montan Company has been formed at Wiesbaden by the Banque Commerciale de la Sarre of Saarbrucken, with a share capital of 121,000,000 marks. The company has taken over the iron ore mines of four corporations—Friedrichshoffnung, Alter Garten, Konigsberg, and Rheinberg—whose properties are in the vicinity of iron ore mines belonging to the F. Krupp Company.

It is reported that the negotiations for the transfer to the Russian Asiatic Corporation of the Friedenshütte of the Upper Silesian Railway Requirements Company, which is now situated in Polish territory, have failed to mature. The German proposals, it is said, afforded no basis for consideration on the part of the English interests.

CONSOLIDATED PNEUMATIC TOOL COMPANY, LIMITED, of Egyptian House, 170, Piccadilly, London, W.1, have removed their pneumatic and electric repair shops and showrooms from Petty France Street, Westminster, to Bramber Road, West Kensington, W.14. Mr. R. Jones, manager of the company's office at Amarchand Buildings, Ballard Road, Fort, Bombay, has retired owing to ill-health, and Mr. C. C. Walcott has been appointed his successor.

Oxygen and Metallurgical Processes.

MR. COSMO JOHNS, of Sheffield, made a contribution to the joint discussion of the Faraday Society and the British Cold Storage and Ice Association on the generation and utilisation of cold. He said that most of the useful metals in present-day practice are extracted from their ores and refined for industrial use by processes which involve the use of atmospheric air for the combustion of carbonaceous matter, silicon, phosphorus or sulphur, to provide the heat required. These processes have become standardised to a large extent, and are based on the assumption of the invariableness of the oxygen content of the atmosphere. Obviously the oxygen enrichment of the air used would alter the conditions under which those metallurgical processes which depend on oxidation of some fuel for the heat required are carried out, and though it is difficult to predict what would actually be the effect of such altered conditions, yet enough is known to enable us to say that revolutionary changes in metallurgical practice would result. The processes now employed, and the types of plant used, are the result of gradual evolution of industrial practice. Our knowledge of the reactions that occur are imperfect and almost entirely restricted to our knowledge of what occurs when ordinary air is used. But though it may be difficult to predict the actual changes in practice that would result, it is comparatively easy to review the possibilities. It is important to note, however, that what is contemplated is not the use of pure oxygen, but the availability of a mixture with 30 to 40 per cent. of oxygen, or even less.

The modern blast-furnace plant would obviously undergo a startling change in its design and arrangement when it had no longer to handle the present huge volumes of dust-laden heated combustible gases to effect difficult heat exchanges with the incoming air to secure fuel economy. The hot-blast stoves would probably disappear, or be much reduced in size. The furnace itself would be reduced in height, and the whole plant, when the changes had been completed, would bear but little resemblance to the equipment found necessary to-day for the production of pig-iron. The Bessemer converter, whether acid or basic, has been evolved on the assumption of an invariable oxygen content of the air blown in. Given the possibility of varying and controlling the oxygen ratio in the air employed, we should find the character of the process completely changed.

In the acid process the order in which carbon and silicon are removed depends on the temperature. In the basic process it is almost certain that by controlling the temperature it would be possible to oxidise the phosphorus before all the carbon had been removed, and thus the injurious after-blow would be avoided. This temperature control could be effected if the oxygen content of the air blown in could be varied. The regenerative open-hearth furnace is costly, complicated, and inefficient from the thermal standpoint. If oxygen-enriched air could be employed for the production of the fuel gas, and for its subsequent combustion in the hearth of the furnace, it would be possible to effect a startling and beneficial alteration in the plant. The uni-flow furnace would become a possibility, and there would be a very desirable simplification in the design of the furnace. A neutral or oxidising flame would be at the command of the operator, while the melting and refining operations would be accelerated. The waste gas of the furnace would be much richer in CO_2, and with added oxygen rich air would be ideal for blowing into the gas producer, thus enabling a fuel gas rich in CO to be supplied to the furnace.

Owing to the slight difference in density of oxygen and nitrogen it would appear that centrifugal methods for their separation are not very hopeful. Can any refrigerating system be devised which will give oxygen enriched at a commercial price? Any such refrigerating system should be able to use as the source of the energy it requires the sensible or potential heat of the products of the metallurgical process where it is employed, if carbon be the fuel used in the process. If a suitable cycle can be discovered for effecting the partial separation of the two mixed gases, for complete separation is not required, then a vast field is available for the use of oxygen-enriched air.

Institution of British Foundrymen.

LANCASHIRE BRANCH.

Discussion on Mr. Young's Paper on the Manufacture of Coke for Industrial Purposes.*

At the annual meeting of the Branch held in May, Mr. A. D. Young, of Burnley, read the first part of a paper on the manufacture of coke for industrial purposes. He now gave the second part of it, which dealt with the requirements of the iron trades. Opening the discussion, the chairman said coke was a very important factor in a foundry, and they welcomed anyone who could add to their knowledge, especially if he could indicate some way of inducing the makers to improve the quality. Lately there had been a distinct improvement in certain brands; on the other hand some had fallen off. They wanted a coke with considerably less sulphur and ash.

Foundrymen should Issue Coke Specification.

MR. YOUNG said it was easier to ask for low sulphur coke than to get it. As he viewed the situation foundrymen had to make up their minds what they wanted, what they would take and what they would not take. If they went on taking what was offered suppliers would continue to send it to them. If a definite standard specification was established it would be a basis when buying coke, and buyers could complain and refuse material when below the standard. The paper indicated what had been accomplished elsewhere to attain a standard specification. The results, so far, had not been ideal, but they certainly helped. Research associations were investigating various subjects in connection with combustion, and possibly they would turn their attention to coke, and supplement the work already done on this material.

MR. HOGG, of Burnley, asked whether Mr. Young could state the reason for both inferior and some of the good brand cokes having a high sulphur content, 2 per cent. or more; did he know of any method of desulphurising the coke after it got into the foundry? When trade was good, it was difficult to get good coke, and the latter question became both pressing and valuable if it could be accomplished cheaply.

Experiments on Sulphur Removal.

MR. YOUNG said the subject of commercially desulphurising coke had been before the interested engineers' associations, but nothing had been proposed which could be said to be satisfactory. There had been a suggestion that coke should be quenched in an excess of water or steam, so that on combination, the sulphur would unite with the hydrogen liberated from the decomposed steam and disappear into the air in the form of sulphuretted hydrogen. Certainly a small amount would be carried away by this method, but the probabilities were that it would not be above 1 or 2 per cent. of the total sulphur present. The matter should be looked at from the point of view of what was the sulphur doing there and how did it get there? It occurred in three forms, iron sulphide or pyrites, organic sulphur and the calcium sulphate. When the coal was carbonised the sulphur in the pyrites, if not in double combination, would be volatilised and pass away in the gases, but supposing this removed all the sulphur in the pyrites there was still the calcium sulphate and organic sulphur left in the ash. That was fixed and could not be removed. It seemed that the only way in which a coke free from sulphur could be obtained was by judiciously picking and well washing the coal before carbonisation. Until some cheap and efficient process was evolved it remains necessary to choose coals which were fairly low in sulphur and well wash them so as to have as little dirt as possible before carbonising.

In the States MR. Powell has investigated the reactions of coal-sulphur during the coking process and suggested the use of hydrogen as a desulphurising agent, the sulphur being evolved as sulphuretted hydrogen. The results on an experimental scale were exceedingly good, but the process has not been tried in practice.

Quenching the coke by water with the addition of hydrochloric acid has been proposed for the removal of sulphur, but the process is prohibitive due to cost of working.

The CHAIRMAN (Mr. R. A. Miles) suggested that it is very difficult to change one's source of supply.

MR. YOUNG agreed, and thought the matter ought to be examined, also from the point of view of the coke-oven manager. As a rule an order for coke did not specify its use, which obviously varied. People were beginning to realise what could be done as to the manufacture of different grades of coke, and practically all the coke-oven builders had a staff of research chemists. If anything was possible they were in a position to develop it. But until the foundryman could say definitely what was needed and insist upon it, he must take what he could get.

Lime Covering During Coking.

MR. HOGG asked whether a layer of lime placed on the top of the coal before carbonisation, say in a beehive oven, would have any effect upon the sulphur.

MR. YOUNG replied that he did not think for a minute that it would. The lime itself would not absorb sulphur from the coal being carbonised; but, assuming that it was in a position to absorb sulphur, it could only absorb sulphur from the gas which passed through it; it could not absorb sulphur from the coal below. Some seven or eight years ago, in an attempt to reduce the amount of sulphur in town's gas, a process was devised whereby a small amount of lime could be mixed with the coal. It was known as the "liming" process. As the coal passed down into an elevator, boot, or into any other convenient apparatus, just before it entered the retorts, a jet of steam was blown on to it, and deposited a small charge of powdered lime, covering the coal with a thin film of lime, just as if it had been dusted with a flour dredger. This was adopted by Mr. Patterson, the Gas Engineer of Cheltenham, who found improved results by it; from a gas-making aspect, the sulphur in the gas was certainly reduced a little. But that method was not applied by any by-product coking firm producing coke for industrial purposes, as the lime would still be in the ash of the coke. It was applied in one or two gasworks, but not generally. Other methods of reducing the sulphur compounds in the gas were handier. The Fuel Research Board and Prof. Cobb, of Leeds, were researching on the subject of cell space. One must have a coke that had a certain porosity, so that the gases would get it and pass through it for combustion to be completed rapidly. At the same time, the coke must have sufficient hardness and strength for the purpose for which it was required. Not much had been done in the matter up to now, but he thought the question of cell space would become very important in the future in relation to the combustibility of coke. Porosity was formerly thought the main factor, but now the question of cell area was considered important. If the user could get coke of the same strength, but with a larger cell area, so much the better. Coke was no use unless it was combustible, and the larger the cell area, the more combustible it was.

Foundry Requirements.

MR. YOUNG, replying to the Chairman's query as to whether any simple practical means of ascertaining the cell area existed, stated that it was a very complicated matter, as one required to know much about the size and thickness of the cell wall material and distribution of the cell area. In the course of a year or two, more information would be available. But what really concerned foundrymen at the present moment was the adoption of a standard specification to obtain a standard product. When the specifications quoted in the Paper were examined, the matter would be a little clearer than it now appeared. The foundryman did not want coke that had "black ends" in it, because those indicated that the material had not

* This Paper was printed in November 23rd issue of the FOUNDRY TRADE JOURNAL.

been properly carbonised. It should be dense, have a close texture, and should have a metallic ring when dropped or struck, and not a dull thud. He should also beware of coke containing red rust spots. "Rusty" coke shows the presence of iron oxide, and invariably contains a high percentage of sulphur. Coke containing a large amount of shale will not be conducive to economical working. The foundryman's preference for a good silver-grey colour can be understood, as his experience tells him it has been properly coked and quenched.

Size of Coke.

MR. SUTCLIFFE asked whether, in cupola practice, it was better to have the coke in large lumps or in small.

MR. YOUNG said very small coke was not of much use; when very fine it clogged the cupola. It depended upon what suited the particular size of plant. Practically the same thing occurred in gas-producer practice; one plant would work with a fairly large coke, and another would not. A few trials with coke graded to different sizes would show which was the best to work with. Probably the medium size was the best. With very large lumps the gases got away too easily, and carried away surplus heat, which would be taken up if the coke were smaller and the passages between more irregular.

MR. SUTCLIFFE said, in a beehive oven, one always found a central split or fracture when the door was opened. What was the cause of that?

MR. YOUNG said the same thing occurred in by-product ovens. In beehive ovens carbonisation started at the bottom, and it also went from the top downwards. At the bottom the coal was carbonised fairly quickly, but in the middle there was a portion which was more or less plastic, due to the fusibility of the coal because of the pitch and tar which had settled in it from the gases, it being the last portion to become coked. The strength of the coke was somewhat proportional to the length of time it was subjected to the coking temperature, and the result was that, when raked out, it usually divided in a fracture down the middle.

Ageing of Coke.

MR. S. SMITH asked whether the keeping in store, say, for 12 months, had a detrimental effect?

MR. YOUNG said the constitution of the coal must be considered. According to Professor Lewis's views—they were perhaps not exactly correct, according to present-day knowledge, but they gave the best explanation—there were four things in coal:—(1) The carbon residue; (2) what he called the humus bodies; (3) the resins; and (4) the hydro-carbons. In the course of time the humus bodies would increase more or less at the expense of the resins, which, through oxidation, deteriorated in quality. When the resins so deteriorated, the coke formed was of inferior quality. He thought it was rather a controversial question whether coal was better kept under cover or in the open. Generally, coal would not oxidise so much if kept in a covered store, with a roof above, because there was not a constant change of atmosphere.

MR. SMITH said his question referred to coke, not coal.

MR. YOUNG said he was of opinion that coke did not take any harm through being stored in the open, provided it did not get wet. There was often a tendency for coke to break down into breeze to some extent. Supposing there was 5 per cent. of breeze when the coke was first bought, the proportion might be increased to nearly 10 per cent. at the end of six months. But the coke itself would not alter in composition. The proportion of breeze was much increased by repeated handling of the coke, especially if the coke was dropped from any height.

MR. SUTCLIFFE: If the proportion of breeze increases from this cause, how is the coke going to stand the burden when it gets in the cupola?

MR. YOUNG said, apart from the fact of breaking up, the coke itself would be no worse. A good hard coke did not break up to anything like the same extent as a soft coke. He agreed it would not stand as well in the cupola, and the extra small or breeze may disarrange the working of the cupola. It has been proposed in blast-furnace practice that it would pay to screen out the small before using the coke, due to the increased output of the furnaces when using coke of proper size.

MR. SMITH: The coke would then become more friable.

MR. YOUNG said he had heard it expressed that coke could stand for 20 years without taking any ill-effects, but was not in agreement with this view. His own experience of the storage of coke at gasworks was that it did not deteriorate as regards its burning qualities, but the percentage of breeze increased as the height of the store heap increased. The formation of excessive breeze, in his opinion, was due to overcoking or improper quenching, but metallurgical coke was not so likely to break down in storage as gasworks coke, as it is more dense and less friable.

Vote of Thanks.

MR. H. SHERBURN, in proposing a vote of thanks to Mr. Young, said they were very fortunate in getting the views of a gentleman who was outside the foundry industry, and who looked at these matters from a judicial standpoint. He had not shown them, however, how they could get coke free from sulphur. Sulphur was blamed for many things, and appeared as a good peg to hang troubles upon. At one of the Conferences of the Institution it had been stated that it was not proved that sulphur, up to a certain percentage, was actually an evil; in fact, reasons were given which seemed to show that it was beneficial under certain conditions. The situation was still very obscure and complicated by much prejudice. Probably a greater problem for the foundryman was the question of uniformity. Uniformity in coke was as important to them as uniformity in pig-iron, but they were far from getting it, and in this variation of materials—both in foundry materials as well as furnace materials—lay much of the difficulty which besets the foundryman to-day.

MR. GRANDISON seconded the vote of thanks, which was passed unanimously.

NOTES FROM THE BRANCHES.

Newcastle.

From the November meeting a message of congratulation was sent to Mr. Edward Smith, a past Branch-president, on his re-election as Mayor of South Shields.

Mr. H. A. J. Rang was accorded the thanks of the meeting for the time and work he has expended on the Branch booklet.

Patent Specifications Accepted.

Particulars of Complete Specifications accepted, furnished by Mr. Eric Potter, Patent Agent, of 27, Chancery Lane, W.C.2. Printed copies of the specifications in the following list are on sale.

Mechanical Transmission and Appliances.

172,931. HOLTE, H. Centrifugal friction clutches. (December 14, 1920.)

186,054. VULLIERME, M. Shaft coupling for damping engine pulses. (September 13, 1921.)

Plant.

188,379. GROTE, L. Method of and means for mounting liquid hydrocarbon burners on furnaces or other apparatus. August 5, 1921.

188,422. BURGESS, C. L. Fire-bar for boilers and other furnaces. August 26, 1921.

188,445. CLAYTON, H. F. Oil-burning furnaces. September 12, 1921.

188,515. METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED. Condenser systems in steam-power plants. October 29, 1921.

188,547. MILLINGTON, W. E. W. Centrifugal pumps. November 28, 1921.

188,550. GIBBONS, BROS., LIMITED, and COOK, N. G. Machines for discharging and charging furnaces or retorts. November 30, 1921.

174,055. SUCZEK, R. Turbines. (January 10, 1921.)

188,579. FERRALL, M. Chain-grate furnaces for boilers. January 3, 1922.

188,623. RIGBY, T. Preheaters for evaporators, etc. (May 10, 1921.)

An Apprenticeship Course in Foundry Practice.—XXII.

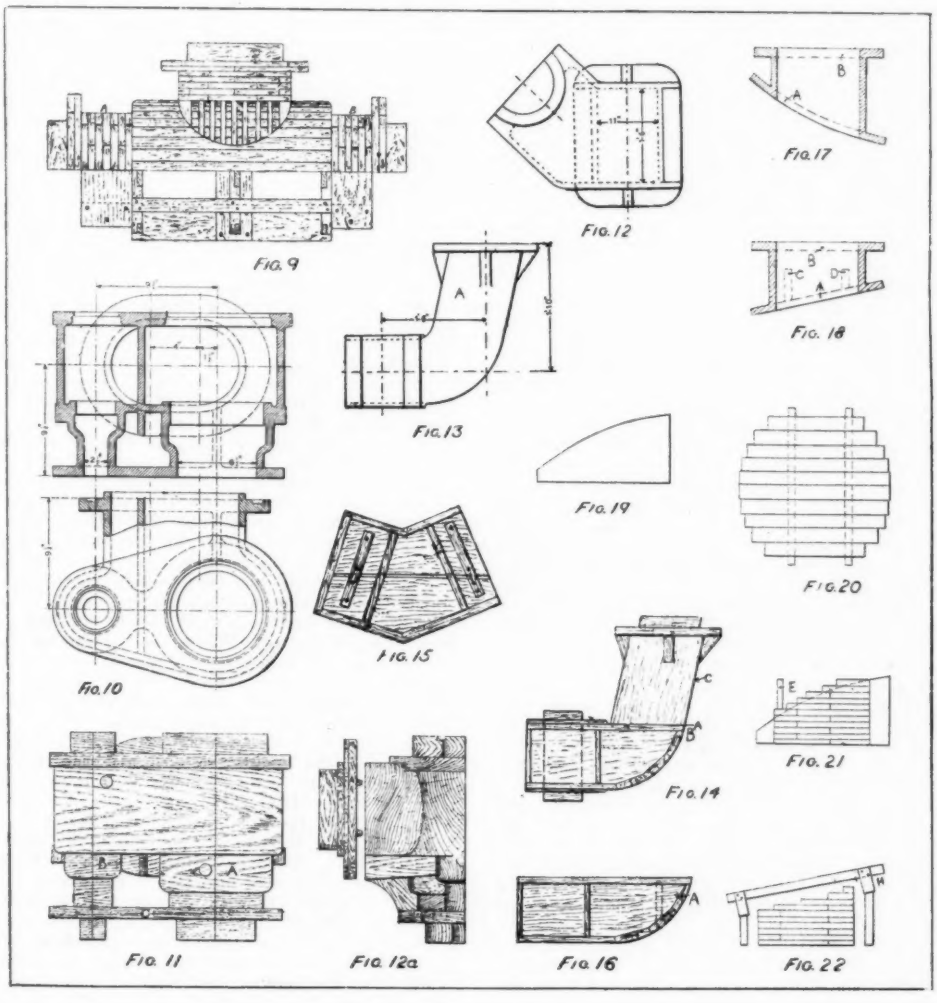
By Ben Shaw and James Edgar.

BUILDING PATTERNS. EXAMPLES OF DIFFERENT TYPES.

PART II.

Plain Cylindrical Patterns.

We shall now leave the separate consideration of detail work, and deal with a few simple patterns which will cover many of the difficulties with which the apprentice is faced. Fig. 9 shows a pattern for a cylindrical casting, the large-body diameter of which is 2 ft., while the flanges are 2 ft. 2 in. dia. and the branches 18 in. dia. The pattern may be built of separate units, that is, the joint frame could be dispensed with, but a permanently better joint is obtained and there is less trouble involved in building when joint plates about 1½ in. thick are used. The drawing is very nearly self-explanatory. Circular grounds are made and screwed to the frames, as shown, and the staves secured to them. The shape may be completed on the frame, or a more convenient method can be adopted of introducing stays, to maintain the correct position of the grounds, when it can be built as a separate piece and attached to the frame when completed. The same may be said of the segmental ends A and B. It will be observed that the frames do not extend beyond the backs of the flanges, which is good practice for several reasons, one being that an alteration in the diameter of the flanges is more easily effected. Attention may be drawn to the branch, which shows a different fitting from what we have already described. The joint might or might not be carried to the back of the branch flange, depending largely on whether the work would be likely to be altered. In the illustration part of the branch is made by the skeleton method, but, if many castings were required, it would be profitable to fit blocks to form a solid exterior, a jig being used for the purpose. This is a form of construction that covers a variety of patterns. The frames would, in the first place, be finished with a square edge, the main barrel screwed to it from the joint face, after which the end parts A and B, the flanges and prints would be screwed in position. After the branch had been finished, the two half-patterns would be clamped together, and the edges of the joint frames pared and planed to correct shape.



A Combined Valve Chest.

The single-valve chest does not offer many special difficulties, but it will be advisable to consider briefly a combined valve-chest, which is, in one form or another, a very common form of casting. Let us suppose that a pattern has to be made for a casting similar to Fig. 10. If a first-class pattern were required, the flange timber would be made sufficiently thick to allow of the fillet between the flange and body being cut from the solid timber, while the branches A and B (Fig. 11) would be turned with prints attached. More ingenuity is necessary in many cases to make work quickly, and at low cost, than a first-class job which occupies more time, and this pattern could be made very much quicker if only one or two castings were required. It may be agreed

by some that the apprentice should only be shown the best work, but, on the other hand, the highly-skilled craftsman is the man who can adapt himself to circumstances; a cheap pattern may, after all, be a very good pattern. The simplest method of making such a pattern is by means of sectional construction, as shown at Figs. 11 and 12A. Fig. 11 illustrates half of the pattern looking on the joint, and Fig. 12A is an end elevation showing the branch. It will be noticed that several different thicknesses of timber are required to make up the width over the prints. The rounded parts shown on sections A and B and the junction between the flanges of section C are worked by hand. The centres of each piece are carefully squared over, and the thinner sections screwed to the main section. The method of constructing the top branch and flange is apparent from the drawing.

Bracket Patterns.

Bracket patterns constitute a different branch of pattern construction. Some brackets of boxed design, having many openings or "windows" through the walls of metal, can be most easily made by coring the entire inside shape of the bracket, and some small delicate brackets must be built on a block which forms a core print. When a bracket is of very light design and awkwardly shaped, the method of coring should be considered. In any general article it is not possible to cover the whole range of bracket types; nor is it necessary, if the apprentice has profited by previous articles of the series. But we shall describe one type of bracket which must be boxed up, and which frequently perplexes experienced men. We refer to a weight- or wyper-shaft bracket. These are not all of the same design, but they are sufficiently similar to be covered by one design, such as is shown in Figs. 12 and 13. One difficulty results from the square section not being all in the same plane, and this difficulty is increased by the large radius shown in Fig. 12. Sometimes the job is simplified by the part A (Fig. 12) being quite short—in fact, merely a flange resting on the bottom part—and occasionally there is a large radius, the two sides meeting with the sharp corner rounded off. This is one of the few jobs where the patternmaker has not to give special consideration to the moulder, but can concentrate his attention on constructing a really strong pattern. An irregular-shaped pattern like this must be very strongly made, or a knock in the foundry will render it inaccurate.

The body of this pattern must be boxed up in two distinct pieces, that below the line A-A in Fig. 14 forming one piece and that above the other (Figs. 15 and 16) shows the method of boxing up. B is a plate which forms the base on which the work is built. A view looking on the plate when the end and sides have been screwed to it is shown at Fig. 15. It will be observed that the end A is let into the sides, which prevents any possibility of it being knocked in. The sides have to be in two lengths, butted together. With regard to the thickness of timber, it should not be less than 1¼ in. The large radius would be staved as shown at A (Fig. 16). This completes the boxing-up of the bottom part of the pattern, and boxing the top part C (Fig. 14) is comparatively easy. The shape of the sides is obtained from the full-sized drawing, and they should be checked at the ends, so as to form a shoulder for the end pieces.

The weight-shaft bracket pattern described might be moulded with the square flange down, the moulder either making a joint round the large radius and down to the top of the square flange or carrying it along the line A-A (Fig. 14), in which case the square box would have to be screwed, so that the moulder could loosen it in the sand and draw it out after the bearing piece had been withdrawn.

Patterns for Castings to Fit on Irregular Shapes.

Before leaving the subject of pattern building we shall describe a job of a type which presents unique difficulties of construction, although in design it is very simple, and which also demonstrates the great usefulness of hermaphrodites. This is a casting (Figs. 17 and 18) which fits on a ship's side. For cheapness and effectiveness a shell pattern is better than a solid pattern and core-box, because of the awkward flange face. Only approximate particulars are usually given on the drawing for the shell flange A (Figs. 17 and 18), the job being usually set down from templates or moulds supplied by the moulding loft, the object being to have the flange B vertical when in position on the ship. After the job is set down two sets of templates must be made by the patternmaker, the one set to be used when building the body and the other set when building the flange A.

Considering the flange A first, the positions of the templates are set down on the drawing board as C and D (Fig. 18), the other view of them being as in Fig. 19. The flange should be built on top of the templates, which have been fixed to a level board. If it is of large diameter—say over 2 ft.—strips of timber 3 in. broad will be satisfactory; but if it is a quick radius, it will be well to have them narrower. A safe rule is to keep them as broad as possible without it being necessary to plane them concave and convex. This flange, as it will appear on the building board, is shown at Fig. 20. The strips should be carefully jointed and glued, and a screw fixed at each end. If care has been taken, scarcely any finishing of the flange faces will be necessary. Before it is lifted from the building board, centre lines must be lifted as a guide for it being screwed to the body of the pattern.

The templates necessary for the body are similar to those made for the flange, but they must be placed outside the diameter of the body. The use of them when building saves time and timber, obviating the building of the ring of parallel depth. A straightedge shows the height necessary at the various points on the circumference. Fig. 21 makes this clear. When the ring is built—and it ought to be well glued—the centre line should be lifted to the bottom course of segments from the drawing board. Lifting the work now, centre lines can be drawn across the face. This will facilitate replacing the ring in the proper position when the top is ready to be worked off to the shape. Temporary legs ought now to be screwed to the bottom course of segments to the height of the top course, as at E (Fig. 21). If the outside diameter is now drawn on the face, the work can be easily sawn at the band-saw resting on the legs. When the outside has been either planed off or finished off at the sandpapering machine, the inside diameter can be gauged on the top side, the legs being removed. When the inside has been finished off, the ring can be replaced on the building board and planed off, using a straightedge. A quicker method is to make a gauge by means of a straightedge and hermaphrodites. Two thin strips can be secured to the straightedge, which will rest on the templates, and raise the straightedge sufficiently high to clear all the segments. The hermaphrodites are set to the distance H (Fig. 22). As the straightedge is lowered on the templates, the hermaphrodites should be held at right-angles to its edge and a line drawn. If lines are drawn inside and outside, it will be a simple matter to rough off with a gouge, finishing with a chisel. When this is done, the body can be screwed to the flange and the hermaphrodites again brought into use to draw the flange the parallel width from the body. The inside of the flange can be cut out with either a jig- or a pad-saw Making and fixing the top flange is a simple matter, which it is unnecessary to explain. Usually a job like this has fitting strips, but they need not occasion much trouble. They should be got out as segments broader and thicker than required. Slippers or wedges can be inserted at the ends to raise the segments from the flange, while hermaphrodites are used to draw a line on them parallel to the flange. The segments can then be finished by saw and spokeshave, and gauged to a thickness. It is advisable to screw them in position and draw the diameter on the face. They can then be unscrewed and finished off, and replaced. The pattern can now be sandpapered, and any ribs or bosses and fitting strips screwed on.

THE BUSINESS of Clark's Machine Tool Company, Limited, of Luton, has been taken over by the Luton Tool Company, Dunstable Road, Luton.

Some Tests for Foundry Sands and Their Practical Application.*

By W. WEST, A.M.I.Brit.F.

Scope of Work.

Many excellent articles on the subject of foundry sands have recently appeared in various technical journals, which give the broad lines on which research is at present being carried out. As a metallurgist, the author follows the progress with great interest, but it is now proposed, in a simple way, to deal only with the basic principles upon which sand mixtures should be built, demonstrating them by a few practical tests whenever possible, confining the subject more particularly to the difference in properties required of sands for the iron foundry and those used in the steel foundry.

The problems of the iron foundry are not nearly so pressing as those of the steel foundry, and the cause is solely due to the higher temperature of the steel. The average iron foundryman fails to realise this immense difference, for troubles such as blowholes, scabbing, burning-on, cracks due to contraction, which are periodic visitors to the steel founder, only occasionally, and then in a mild degree, come the way of the iron foundry.

Sands, therefore, which are used for iron and non-ferrous moulding, cannot be used at all in the casting of steel, for the reason that they are insufficiently refractory and, on coming in contact with the molten metal, fuse under the high temperature and become incorporated in the surface of the steel.

Influence of Process on Sand.

It becomes, therefore, a great necessity to understand the principles of sand-mixing for the various branches of founding, and the peculiar demands of each branch. In the author's experience, a great part of which has been associated with the manufacture of steel castings, he has found that steel from the different processes of manufacture demand different properties of the moulding sand to withstand its own peculiar action. Steel prepared in Tropenas converters shows the greatest tendency for burning-on, electric steel less so, and, least of all, open-hearth metal.

Undoubtedly the "bite" of converter steel is due to the very hot metal obtained, combined with the possible action of occluded gases. However, there is sufficient evidence to show that, while a great number of sands are available for the iron foundry, improvement can always be obtained by intelligently using the various kinds to obtain consistently good results. It is proposed therefore to give the broad principles of sand-blending.

Composition as Indicated by Ultimate Analysis.

Many of the physical properties which characterise various sands used for moulding can be directly attributed to the composition, so that, while an analysis of a consignment of sand will yield little or no information to the foundryman, it is a contributory factor to the proper understanding as to the behaviour of a sand under practical conditions and the final results to be expected.

As is generally known, sand is formed by natural decomposition of granite rock, through long periods of time, and is composed of three distinct substances:—

Quartz.—This is simply silica or pure sand, varying in grain size, and in shape angular and round. It gives refractoriness to the sand.

Clay.—Clay is aluminium oxide and silica, combined together, forming aluminium silicate, with which is associated oxide of iron hydrated, which means combined with water. It is the constituent responsible for the bonding quality.

Feldspars.—These are the non-decomposed parts of the rock, containing sodium, potassium and aluminium oxides, lime and magnesia, each combined with silica to form compound silicates.

These reduce the heat-resisting quality and have a fusing influence on the sand.

* A Paper presented to the West Riding of Yorkshire Branch of the Institution of British Foundrymen.

The result of chemical analysis is usually stated in the following "percentage of" terms:—Loss on ignition: Silica (SiO_2), alumina (Al_2O_3), oxide of iron (Fe_2O_3), lime (CaO), magnesia (MgO), and alkalies (*a*) sodium oxide (Na_2O) and (*b*) potassium oxide (K_2O).

It is not always to be understood that a high silica content shown by the analysis is definite proof that the sand is of a refractory nature—though this is true with sea-sand and other unbonded sands—but rather because alumina (aluminium oxide) and silica combine together, forming clay; the analysis reports the total percentage of silica present, which is only partially free in the form of quartz, the constituent which gives refractoriness.

Similarly, it is misleading to suppose that the amount of alumina, as shown by the chemical analysis, represents the total bonding property of the sand, for much of it is demanded for the formation of feldspar, which, as stated, contains silica, alumina, soda, potash, lime and magnesia, combined together in natural order and proportions.

The occurrence of oxide of iron in the hydrated form, a colloidal (or jelly-like) form with water, is now rightly considered as holding a relation to the bonding quality, and this can be determined. The percentage of iron oxide as given by the analysis does not give the exact influence of this as a bond, for a sand having 5 to 6 per cent. simply as iron oxide may have practically no bonding, while that percentage of iron oxide occurring in the colloidal form with other constituents its influence is considerable. One can therefore consider that this influence as a bond may be due to the property of the colloidal iron oxide retaining water in the sand mixture, and thereby giving strength without an excess of silt and clayey matter, which would choke the pores of the mould.

Because of the low fusing-points of lime and magnesia, these constituents should be as low as possible to avoid trouble due to the sand sticking to the skin of the casting. Quantities up to 1.0 per cent. of the combined substances are permissible and will give no detrimental effect.

Sodium and potassium oxides are totally undesirable for the same reason. For example, an undiluted Mansfield sand is not suitable for steel castings, because it contains 2 to 3 per cent. K_2O.

It will be seen, therefore, how important it is to make careful interpretation of a chemical analysis, for it does not in any way give direct clues as to the physical properties of the sand which are recognised as of the greatest importance. It is therefore necessary to consider any analysis in the light of other mechanical and physical tests.

Rational Analysis.

A rational analysis indicates precisely the combination of the various elementary constituents shown by chemical analysis, the degree to which combination has occurred depends very much on the amounts of each constituent present. This so-called rational analysis can be arrived at in two ways. (1) From the ultimate analysis by calculation; (2) by various experiments.

As previously mentioned, the ultimate analysis gives exactly the total amounts of each constituent of the sand individually, and does not offer any direct information regarding the properties of the combined constituents. Now, taking for example a sample of north Yorkshire yellow moulding sand, which has the following analysis:—Silica (SiO_2), 89.31; alumina (Al_2O_3), 6.09; oxide of iron (Fe_2O_3), 1.94; lime (CaO), 0.35; magnesia (MgO), 0.17; sodium oxide (Na_2O), 0.57; potassium oxide (K_2O), 0.34; and moisture, 1.80 per cent.

Of the above, potash, soda and lime are probably present as undecomposed feldspars, occurring in the following combinations:—(1) $K_2O.\ Al_2O_3.\ 2SiO_2$; (2) $Na_2O.\ Al_2O_3.\ 2SiO_2$; and (3) $CaO.\ Al_2O_3.\ 2SiO_4$

From the atomic weights (potassium (K) = 39, oxygen (O) = 16, aluminium (Al) = 27, and silicon (Si) = 28), that is, the weight of one atom of each element compared with the weight of one atom of hydrogen, compound (1) will have the following relative weight:—$K_2O - Al_2O_3 - 2SiO_2$ 78+16=94, 54+48=102, 56+64=120, which means 94 parts K_2O combined with 102 parts Al_2O_3, so that 0.34 parts found by analysis will combine with

$$\frac{102 \times 0.34}{94} = 0.37 \text{ per cent. } Al_2O_3.$$

Similarly, 057 per cent. Na_2O requires 0.93 per cent. Al_2O_3, and 0.35 per cent. CaO requires 0.63 per cent. Al_2O_3. Therefore, allotting to the sodium, potassium and lime the necessary alumina and silica to produce feldspar, we find there is a balance remaining of 4.16 per cent. Al_2O_3 unused, or is free as bond.

This 4.16 per cent. is present as clay, and has approximately a composition:—

Al_2O_3 $2SiO_2$ $2H_2O$.

54 + 48 = 102 56 + 64 = 120 4 + 32 = 36

Again using the atomic weights, it is found 102 parts Al_2O_3 require 120 parts SiO_2, 4.16 parts Al_2O_3 require $\frac{120 \times 4.16}{102} = 4.9$ per cent. silica.

Thus 4.90 per cent. of silica is required to combine with 4.16 per cent. of free alumina to form pure clay (or kaolin).

Now the feldspars require silica in their combination as follows:—

K_2O	0.34 per cent.	× 1.085	= 0.37
Na_2O	0.37 per cent.	× 1.935	= 1.10.
CaO	0.35 per cent.	× 2.143	= 0.75.
MgO	0.17 per cent.	× 3.000	= 0.51.
			2.73.

Therefore the silica required for combination with alumina and feldspars totals 4.90+2.73 = 7.63 per cent. silica. Subtracting this amount from the silica found by analysis, 89.31−7.63 = 81.68 per cent. quartz free to act as refractory.

Now, in the formation of the clay, two molecules of water are required, so calculating in a similar way, we get:—

102 parts Al_2O_3 requires 36 parts H_2O.

4.16 parts Al_2O_3 requires $\frac{36 \times 4.16}{102} = 1.46$ parts of water.

Subtracting from the amount shown by analysis:—1.80−1.46 = 0.34 remaining for the oxide of iron. Therefore the analysis shows a clay bond containing:—4.90 per cent. SiO_2, 4.16 per cent. Al_2O_3, and 1.46 per cent. water, making a total of 10.52 per cent. total clay bond. The rational analysis of this sand thus becomes:—81.68 quartz, 10.52 clay bond, 2.28 iron bond, and 6.09 per cent. feldspars. Further calculation is not necessary, for these items give the information useful to the foundryman.

The percentage of quartz immediately gives the approximate silica content, which information is of great value in selecting sands for steel castings work, where refractoriness is extremely vital. It is the percentage of free silica or quartz in a sand which gives the property to withstand heat. The clay substance can also be determined by the bond of absorption method, but the amount given by the rational analysis will, if used with caution, give assistance to a satisfactory conclusion.

Direct Methods of Ascertaining Sand Values.

Schultze used an apparatus to determine approximately the percentage of quartz and clay which we have just calculated. It consisted of taking a weighed quantity of sand, which is introduced into a conical vessel in small portions at a time. The clean sand falls to the bottom, and, by suitably regulating the outflow of water, only the clay which is carried upward by the excess of water passes away, together with a little of the finest sand particles. The washing of 50 grammes of sand should be complete in about 3 hours, if the funnel be periodically used as a stirring rod; then the residue is carefully washed out, dried, and weighed, to give an approximate idea of the silica sand present.

Another simple test to ascertain the proportion of the constituents in a sand, by measure, instead of by weight, is to half fill a stoppered graduated cylinder with the sand, add water to the 500 c.c. mark, and shake until all the lumps are broken down; then allow to settle. The heavier grains are seen settling to the bottom, and the layers of sand get gradually finer until on the top of these a depth of mud, due to the clay, is noticeable, and above that clean water.

Refractoriness.

Little remains to be said on this question, but the one basic fact holds good that the higher the percentage of quartz, the greater will be the resistance to high temperatures. It will readily be noticed, therefore, that for steel casting refractoriness of the sand is essential—in other words, the quartz content must be higher than the amount present in a sand for iron or non-ferrous casting.

The following tables give a comparison of chemical and rational analysis for iron and steel castings:—

TABLE I.—*Suitable compositions for iron material.*

Material.	Percentage for light work.	Percentage for medium work.	Percentage for heavy work.
Silica	82.0	85.0	88.0
Alumina ..	9.0	8.0	6.5
Iron oxide ..	4.0	2.5	2.0
Lime	0.5	0.5	0.5
Magnesia, Soda .., Potash ..	Low as possible. Each constituent under 0.5 per cent.		
Rational Analysis.			
Quartz	73.3	75.5	80.4
Clay bond ..	17.1	15.0	10.0
Feldspars ..	5.1	6.6	6.6

TABLE II.—*Showing suitable compositions for steel castings.*

Material.	Percentage for light and medium work.	Percentage for heavy work.
Silica	89.30	92.80
Alumina ..	6.17	3.92
Iron oxide ..	2.13	2.48
Lime	0.98	0.50
Magnesia, Soda .., Potash ..	0.50	0.50
Rational Analysis.		
Quartz	82.10	88.4
Clay bond ..	12.10	8.6
Feldspar ..	4.80	3.20

Salt Objectionable.

The presence of salt is extremely objectionable, as the sodium it contains forms very fusible silicates. Sea-sands are therefore not good for foundry use unless they have been previously washed. The degree of refractoriness which must characterise any moulding sand, using this term in the sense of facing sand, must be considered according to circumstances, *i.e.*, kind of metal and method of moulding, whether green, skin-dried or dry sand.

Facing Materials.

The specific use of this term would include all those materials which are used to obtain a smooth surface to the exterior of the casting, and yet at the same time will easily "peel off" after cooling down. The true function, therefore, of facings such as plumbago, blacking, graphite, etc., is in effect to increase the refractoriness of the sand.

Facing Sand.

The general practice in most foundries is to use two kinds of sand, one being a specially-prepared facing and the other backing sand mixed from the floor, so that, after stripping the casting from its mould, it is generally supposed that there is sufficient good facing-sand left unaffected by the heat of the metal that will strengthen the sand pile and thereby render any further addition of new sand unnecessary.

In the iron foundry the philosophy of coal additions rich in gas and finely powdered is still a matter as yet unsettled from a technical point of view, but practical experience has shown that in proportion of one part of coal to ten parts of sand, where little of the coal comes into close proximity of the metal, there is little chance of the gases evolved blowing into the metal.

On the other hand, what actually takes place can be summarised in two ways. Either the gas

formed from the fine coal by contact with the hot metal acts as a cushion between the mould and the flow of the metal, and in this way prevents erosion of the sand, or the volatile hydrocarbons come off from the coal as smoke, and will eventually burn away or be taken up by the metal itself.

It is therefore of importance that the coal dust used should be readily decomposed as the metal flows over it; for this the coal must have a high percentage of volatile with *low sulphur and ash content*.

One can be reasonably satisfied if the ash content does not exceed 10 per cent. and the volatile matter is at least 35 per cent. Another property of the coal dust is its degree of fineness, varying grades of sand requiring various degrees of fineness. A light casting would need a superfine quality to obtain a pleasing result, while with heavy and medium work a coarser grade would be better to assist the venting qualities of the mould.

It is generally accepted that for heavier work more coal dust should be used in the facing, but for reasons of economy, and also that excessive additions result in a bad skin effect, the proportions are made according to the thickness of the casting, and vary from one part of coal dust to 17 parts sand for light castings to 1 part coal dust to 8 parts sand for heavier work.

Blackings or Graphitic Facings.

The primary function of the facing which comes next to the metal is to give the skin of the casting a fine smooth finish. Graphitic facings can be divided up into three classes, each consisting respectively:—(1) Graphite, (2) plumbago, and (3) blacklead. Graphite is unquestionably the most important of the three, for, owing to its natural greasy nature, its high-refractory quality, together with the flakey structure, it is admirably suitable for covering surfaces. However, for commercial purposes it is mixed with other constituents to reduce the resultant cost, and yet achieve a similar result.

Foundrymen are thereby offered all varieties of facings, from the flakey variety down to the material totally lacking of the chief character of graphite—greasiness and flakiness—and is called graphitic anthracite. Adulteration is made by the addition of soapstone, coke, coal, or anthracite to cheapen the mixture.

On what basis then can we establish any rule for guidance as to the particular grade that can be used? All good blackings are composed more or less of graphite; the more it contains, the better the casting will peel from the mould, whether used on green sand or loam moulds. However, care should be taken to consider the size of casting with the thickness of the metal and the degree of heat at which the metal must be run.

For light castings, plumbago has given excellent results, but as the casting becomes heavier and thicker, it becomes necessary to have a facing better able to withstand the bulk of metal and the casting temperature, and to this end various additions are made, differing in each and every foundry. For large work plumbago and mineral blacking, in equal quantities, is used, while round the runner, where the hot metal enters, plumbago, with additions of fireclay or other refractory material, will assist the facing to resist the action of the heat.

It should be emphasised that foundrymen should be on the *qui vive* for adulterations in the blackings which they buy. The preparation of a suitable specification for graphitic and mineral blackings is desired, so that the manufacturer and the foundryman might be protected. When pure, plumbago will contain about 100 per cent. carbon, with very small amounts of ash; from this it varies to 60 per cent. carbon and 40 per cent. ash, and still retains some of the desired properties. In this way it can be discerned that paying for silica or sand at graphite rates is a factor to be avoided.

Mineral Facings.

Soapstone is probably the most well-known of the mineral facings, and carries its name because of the soapy feeling, caused with the high percentage of magnesia which it contains, in the form of silicate of magnesia. This material, however, owing to the mineral compound it contains being fusible at high temperatures, is unsuitable for heavy work, but gives satisfactory results with thinner castings.

Bonding Quality.

Unquestionably, there is no property of moulding sand so important to the foundryman as bonding, for it is of great consequence that copes shall not drop or the surfaces be cut by the stream of molten metal. It becomes, therefore, a necessity to establish some simple means whereby sand-heaps, or consignments of fresh sand, can be periodically checked.

Dye Absorption Test.

Another point of importance is that the more and "fatter" the clay substance, the stronger is the sand, but the venting power decreases proportionately owing to the closing up of the pores between the quartz grains. The test of the bonding power is a very simple one. Fat clays have a greater power for absorbing dyes than the "lean" ones, and this property is used for the basis of determining the bonding power. An aniline dye of great "brilliancy" is taken in given quantity, dissolved in water, and a given weight of sand added. After agitating sufficiently long to give a perfect mixture, the material is allowed to settle until a clear solution remains. The lighter the colour, the greater the dye absorption, and hence the better the bonding power. Comparison is made with a standard solution of the dye itself, and thus a basis of valuation of the bonding power is arrived at.

Strength of Moulding Sands.

This is intimately connected with the amount of clay present, its quality, and the degree to which this bond covers the quartz grains. All successful bonds, whether natural or artificial, belong to that class of bodies called colloids—a satisfactory definition is not desired here, but the best idea of them can be obtained by mention of some of the chief ones, gelatine, albumin, tannin—and stand in definite contrast to crystalloids, of which common salt and copper sulphate are typical examples. Some mention has been made of sands which contain fair quantities of iron oxide, known as ochre sand, or red sands. This oxide of iron is in a colloidal form, which promotes a roughness round the quartz grains, with consequent greater ability of the clay to adhere to the quartz surface.

The amount of water with which a moulding sand is tempered assists the clay bond to cover the grains and to hold them together. In the steel foundry, when green-sand moulds are in vogue, it is of the utmost importance to maintain constant the amount of moisture, as too little means bad lifts and scabby castings; too much may result in gassy castings. The moisture of the sand for green or skin-dried work should approximate between 4 to 5 per cent.

Milling the sand has a wonderful effect of strengthening a sand by bringing into intimate mixture the silica grains and the clay bond. The author's experience has proved that a naturally bonded sand gives better bonding qualities to a sand, and more evenly distributed than additions of fireclay to a siliceous sand.

For the rough idea of the strength of a sand the foundryman has a rule of grabbing the tempered sand, balling it up, and breaking the lump. It may be interesting perhaps to show what has been done by way of comparing the strength of moulding sand when tempered and rammed up into specimen. A mixture of sand is placed in a core-box and struck off evenly with the hand or a flat board, and the errors of unevenly tamping the test bar eliminated by pressing the sand in the core-box by means of a special compressing block. By this means it is possible to compress the volume of sand, which initially occupies a space of 1 in. × 2 in. × 12 in., into a solid core 1 in. × 1 in. × 12 in. The core is then gently pushed towards the end of the base block until it breaks off; the length of the portion of bar breaking off is the measure of the bonding strength of the mixture.

For the purpose of easy comparison, a core which projects over the plate 3 in. before breaking can be stated to have a plasticity of 100. By this method a comparison of various sands is possible, or a simple check can be made on the sand heaps from day to day.

Mechanical Grading.

In the casting of metals if the gases which are liberated cannot escape through the mould they become imprisoned in the cooling metal and produce blow-holes. A moulding sand therefore must be open enough to carry away these gases. The mechanical composition of the sand is therefore of great importance.

The grading is carried out by the use of a set of sieves of given mesh sizes, the sand being previously dried before passing through the sieves. The figures obtained are reported so:—

Coarse sand.	*Medium sand.*	*Fine sand.*
> 0.5 mm	> 0.25 < 0.50	> 0.1 < 0.25

Coarse silt.	*Fine silt.*	*Clay.*	*Total sand grade.*
> 0.05 < 0.10	> 0.01 < 0.05	< 0.01	> 0.1 mm.

The ideal sand would be made up of a uniform grain size and round. It will be readily understood that small grains pack between large ones, whether round or angular, and this means the venting quality is to a great extent reduced.

The mechanical analysis of the yellow moulding sand, the rational analysis of which has been previously calculated, figures out as follows:—

V.C.S.	*C. sand.*	*Med. sand.*	*Fine sand.*
> 1 mm.	> 0.5 mm. < 1.0 mm.	> 0.25 < 0.50	> 0.1 < 0.25
—	0.5 %	1.5 %	74.3 %

Coarse sand.	*Fine silt.*	*Clay.*	*Total sand.*
> 0.05 < 0.10	> 0.01 < 0.05	< 0.01	> 0.1 mm.
7.8 %	2.6 %	13.3 %	76.3 %

According to the standards previously given for rational analysis, this sand would be suitable for use in heavy iron moulding, but the results of mechanical grading proves its unsuitability, for the large percentage of fine sand classifies it as a non-ferrous moulding sand.

Dr. Boswell, in his excellent book on refractory sands, states that when the separate grades of a naturally bonded sand are subjected to chemical analysis a progressive increase or decrease in percentage of the various elements is seen to accompany the grading. The silica content, as one would expect, falls regularly in percentage as the silt and clay grades are approached. All the other constituents increase, particularly the alumina and iron oxide.

In conclusion, as a practical test, the mechanical grading gives a very good idea to the foundryman of any sand, and its suitability for a particular class of work. Combining the results of each analysis, chemical, rational and mechanical, it can be confidently stated that where these are understood, even one might say, in a crude way, a distinct progressive step has been won, and is precursory to many more which science can offer to those in control of founding, when applied to foundry matters in a practical way.

Moulding Sand Investigation.

The American Bureau of Standards is conducting a series of tests to discover a sand with 100 per cent. permeability. The advantage of finding a perfectly permeable sand or one which approximates perfect permeability is obvious. Having a standard sand with a known permeability, the suitability of every moulding sand could be expressed in percentage of a sand found to be 100 per cent. permeable. To accomplish this result, several sands have been investigated. One commercial grade of sand, which is a very pure silica sand of a fairly uniform degree of fineness, has been found on a number of tests, both dry and with as high as 4 per cent. of moisture to be 100 per cent. permeable. Further tests are being made to determine its colloidal matter or any other substances which might affect its permeability.—"Iron Age."

Zinc Industry of Northern France.

The Commercial Secretary at Paris (Mr. J. R. Cahill) has forwarded to the Department of Overseas Trade the following report on the zinc industry of Northern France, which recently appeared in the "Nord Industriel."

The report states that in 1913 France produced 67,890 tons of zinc, of which 47,440 tons, or 69.8 per cent., were supplied by the Departments of the Nord (37,489 tons) and the Pas-de-Calais (9,951 tons). The only other district where zinc was produced on a large scale was the Department of the Aveyron (20,450 tons), where the important works at Viviez were operated by the Société de la Vieille-Montagne. The three zinc works in the Department of the Nord were at Ruby (Société Asturienne des Mines), with 33 ovens and 6,600 crucibles; Montagne (Société Franco-Belge), with 14 ovens and 240 crucibles; and Saint-Amand (M. Bloch), with 12 ovens and 40 crucibles. In the Pas-de-Calais the "Société de Malfidano" operated works at Noyelles-Godault, near Dourges.

All these establishments were occupied and damaged by the Germans during the war. French output of zinc would have fallen by 75 per cent. if the "Société Asturienne" had not created works at Rochefort with a capacity of 6,000 tons of metal, and the "Société Nouvelle des Zincs purs" works at Salindres, in the Department of the Gard, with a capacity of 1,200 tons.

The work of reconstruction, which began after the war, is now virtually completed. Even in 1921 the three works of the Department of the Nord produced 11,768 tons of metal.

French potential output has been considerably increased, not only by the creation of the above-mentioned works at Rochefort and Salindres, but also by the enlargement by the "Société de la Vieille Montagne" of its plant at Viviez, where, in 1916, it installed a new establishment capable of producing 8,000 tons of zinc a year.

It may be estimated that France will be able to produce 100,000 tons of metal, whereas before the war she consumed only 78,150 tons. It is true that there has been a remarkable development of the brass industry, and that before the war France imported large quantities of crude and rolled zinc. Her imports amounted to 40,000 tons of metal, of which Belgium supplied 85 per cent. She was also under the influence of the Metallgesellschaft, of Frankfurt, and the Vieille Montagne, which hindered the expansion of the French zinc industry. Yet even then France exported 3,000 tons of worked zinc, a quantity which could be increased in the future.

The necessary supplies of zinc ore are available. The output of French mines, situated principally in the Departments of the Gard and the Hautes-Pyrénées, could be increased from 46,500 tons in 1913 to 60,000 tons. The ore produced in North Africa could also be reserved for France, which in 1913 received only 13,000 tons out of 112,500 tons.

The danger to the zinc industry of the two Northern Departments lies in the competition of the works in the Aveyron and the Midi and in the development of the electrolytic process, which is making great progress in the United States of America, and is favoured in France by the schemes for the more extensive utilisation of water power. The "Société Vieille Montagne" has already harnessed a fall of 4,000 h.p. in the neighbourhood of its works and acquired rights over another fall close by. Similarly, the "Société de Penarroya" has installed a hydro-electric station of 15,000 kw. at Saint-Lary on the Neste d'Aure, and applied for another concession on the same river in the vicinity of the zinc ore deposits of the Haute-Garonne.

The whole question of the future success of the zinc industry in the North depends on whether they can produce the metal by the electrolytic process at a moderate cost. The works in that district suffer from the high cost of transport of the ore from the mines, and they should endeavour to obtain a reduction in the railway rates from Dunkirk, Calais and Boulogne.

THE LATE Mr. F. Espir, metal merchant, of 3, East India Avenue, London, E.C.3, left £26,468.

Company News.

Parman & Butler, Limited.—Capital £1,000 in £1 shares. Brassfounders. Directors: W. F. Butler, W. E. Parman and H. Walter.

Thermal Engineering Company, Limited, 17, Calabria Road, Highbury, London.—Capital £1,000 in £1 shares. Director: A. R. C. Winnis.

William H. Peregrine & Company, Limited, Walmersley Ironworks, Walmersley, near Bury.—Capital £2,000 in £1 shares. Manufacturers of machinery.

"M.P." Company, Limited.—Capital £12,000. Founders, engineers, etc. Permanent directors: H. J. Newton-Clare, T. Powell and W. S. Newton-Clare.

West Vale Brass Company, Limited, Maude Street, West Vale, near Halifax.—Capital £6,000 in £1 shares. Directors: H. Hinchcliffe and J. W. Gaukroger.

William Gilpin, Sen., & Company (Axles), Limited, Howard Road, Hill Top, West Bromwich.—Capital £100 in £1 shares. Axle manufacturers, etc. Secretary: F. E. Francis.

John I. Thornycroft & Company, Limietd.—Dividend, 3 per cent. on preference and participating preferred ordinary; no distribution on ordinary; brought forward, £55,747; carried forward, £60,758.

Blyth Shipbuilding and Dry Docks Company, Limited.—Profit, less depreciation, £22,697; brought forward, £3,307; available, £26,004; debenture interest, £7,686; final dividend, 9d. per share, making 1s. 3d. per share; carry forward, £6,885.

National Heating Company, Limited, 181, Queen Victoria Street, London, E.C.—Capital £2,000 in 500 1st cumulative preference shares of £1 and 12,000 ordinary of 2s. 6d. each. Engineers, etc. Directors: C. E. Hodge, H. Sandford (permanent joint managing directors), and Mrs. E. Sandford.

Blaenavon Company, Limited.—Debenture stock interest, £9,229; loss for year, £55,301; loss on coal sold to workmen, £13,179; adverse balance brought forward, £1,319 transferred from reserves and renewals funds, £5,000; one year's dividend on preference shares, £3,000; debit balance, £67,800.

Poyser's Patents (1922), Limited, Challenge Works, Dale Road, Matlock, Derby.—Capital £5,000 in £1 shares (3,000 6 per cent. cumulative preference), to acquire the business of engineers carried on by Poyser's Patents, Limited. Directors: J. Holmes (chairman) and G. W. Poyser. Secretary: J. Holmes.

Dorman, Long & Company, Limited.—Profit, £160,368; brought forward, £239,487; total, £399,856; interest on debentures, £35,684; interim dividend on 8 per cent. preferred ordinary shares, £60,000; final ditto, £60,000; directors' fees, £3,000; general reserve account, £40,000; carried forward, £201,172; ordinary dividend passed.

Shotts Iron Company, Limited.—Surplus, £4,230; debenture interest, £2,636; interim dividend on preference, £2,024; depreciation, £26,090; £25,000 taken from contingencies account to meet loss through depreciation of stocks; brought forward, £57,634: ordinary dividend, 7½ per cent., free of tax; carry forward, £44,696.

Deaths.

MR. F. ALGAR, a partner in the firm of F. Algar & Company, iron merchants, of 7, Waterbeer Street, Exeter, died recently.

MR. J. C. DOYLE, who died suddenly at Carlisle recently, at the age of 66, was formerly managing director of Cowan, Sheldon & Company, Limited, crane manufacturers. He resigned in 1920, but remained a director of the company.

MR. J. H. BUCKLEY, director, general manager, and secretary of the Renishaw Iron Company, Limited, Renishaw, died suddenly recently at the age of 55. He had been chairman of the Renishaw Iron Company for 18 years, and a director since 1914.

MR. JOHN GOWER, senior partner of John Gower & Sons, engineers and boiler makers, Elston Road, Bedford, died on November 6, aged 77. After being for some time in the service of J. & F. Howard, Limited, engineers, of Bedford, he started in business on his own account about 50 years ago. The business will be carried on as usual by the remaining son and partner, Mr. F. P. H. Gower.

INDIAN IMPORTS OF CAST PIPES AND FITTINGS.—The total imports during the first half of the statistical year ending September 30 fell from 60 to 29 lakhs. The British share was reduced from 39 to 20 lakhs, and that of America from 20 to 6 lakhs, whereas other countries increased their proportion from 1 to 3 lakhs.

Gazette.

THE ERNSMORE ENGINEERING & TOOL COMPANY, LIMITED, are being wound up voluntarily, with Mr. H. Harris, 4, East Circus Street, Nottingham, as liquidator.

THE first meeting of the creditors and contributories of the London Drop Stamping Company, Limited, 40, Hythe Road, Willesden, London, N.W., will be held on December 15.

MESSRS. W. MARSHALL AND A. WILKINSON, trading under the style of Marshall & Wilkinson, Denton Road, Audenshaw, engineers and pattern makers, have dissolved partnership. Mr. A. Wilkinson continues.

THE PARTNERSHIP heretofore subsisting between Messrs. A. J. Baker and B. Meanley, iron and steel merchants, Lloyds Bank Chambers, Smethwick, under the style of A. J. Baker & Company, has been dissolved.

THE SHEFFIELD STEEL PRODUCTS, LIMITED, have obtained Orders of Court, dated November 6 and 14, for the appointment of Sir William Barclay Peat as receiver and manager of the properties of the following companies:—Eagle Plate Company, Limited, Templeborough Works, Sheffield; Armstrong, Stevens & Sons, Limited, Birmingham; Moses, Eadon & Sons, Limited, Mowbray Street, Sheffield; Oxley Bros., Limited, Templeborough Works, Sheffield; Joseph Peace & Company, Limited, Rutland Road, Sheffield; Steel Stampings, Limited, Cookley, near Kidderminster; W. K. & C. Pearce, Limited, Eagle Works, Sheffield; Hemmings, Limited, Templeborough Works, Sheffield; Boswell, Hatfield & Company, Limited, Templeborough Works, Sheffield.

THE names of the undermentioned companies have been struck off the Register of Joint Stock Companies, and such companies are dissolved:—Aeronautical Engineering Company, Limited, Aero Sheet Metal & Engineering Works, Limited, Anderson's Shipbuilding & Repairing Company, Limited, Chelsea Precision Tools, Limited, Clutchnut Engineering Company, Limited, Expert Metal Workers, Limited, Gerrard Engineering Works, Limited, Ingate Engineering Company, Limited, International Electrical & Mechanical Supplies, Limited, Lattimer Engineering Company, Limited, Lubros Engineering Company, Limited, Ostroyd Company, Limited, Slough Metal Company, Limited, Southern Shipbuilding & Engineering Company, Limited, South Wales Ferro-Concrete Shipbuilding Company, Limited, T. W. Field Engineering Company, Limited, United Electrical Works, Limited, Warstone Engineering Company, Limited, Western Marine Motors, Limited, and the West Ham Engineering Company, Limited.

Personal.

MR. A. H. FELLOWS has been elected honorary vice-president of the Stephenson Locomotive Society.

THE LATE Mr. J. F. Haeberlein, ore merchant, of Whittington Avenue, London, E.C.3, left £67,699.

MR. H. S. DEACON, managing director of Cryselco, Limited, Kempston Works, Bedford, is retiring at the end of the year.

MR. ROBERT DUMBLETON, of Eckington, has been appointed secretary (pro tem.) of the Renishaw Iron Company, Limited.

THE LATE Mr. G. Whitfield, head of McFarlane & Whitfield, rivet manufacturers, Atlas Works, Dunston-on-Tyne, left £14,540.

THE LATE Mr. W. B. Lloyd, founder of Lloyd & Son, Limited, iron founders and metal merchants, of Woolwich, left £13,304.

AN interesting ceremony took place recently, when Mr. John Cross and Mr. J. J. Richards, respectively managing director and secretary of Messrs. Wm. Cross & Sons, Lyng Foundry, West Bromwich, were the recipients of a silver salver and a tea and coffee service from the employés of the firm as an appreciation of the way in which they had managed the affairs of the firm during their 50 years' service.

MR. THOMAS WILKES, managing director of Wilkes, Limited, Grand Junction Works, Darlaston, recently attained his 80th birthday, and to mark the event the employés of the firm have presented him with a handsome timepiece and pair of bronzes. Mr. L. C. Marsden (secretary of the company) also handed to Mr. Wilkes a framed photograph of the staff. Mr. Enoch Wilkes (chairman of the directors), who presided, referred to the long experience Mr. Thomas Wilkes had had in the bolt and nut trade. His experience probably went further back than that of anyone who at present lived in Darlaston.

IRON AND STEEL MARKETS.

Pig-iron.

The near approach of the end of the year, as usual, has had a quietening effect upon movements in the pig-iron markets, and few, if any, developments can now be expected until the termination of the holidays. Reports, however, on the whole, as to the prospects of the trade in the New Year are fairly favourable, the home demand evidencing a steady expansion, consequent mostly upon a healthy revival in the engineering and shipbuilding industries, while the numerous huge schemes of reconstruction are also contributory factors in stimulating consumption of material both at home and abroad. One of the few exceptions to the general conditions is the Scottish pig-iron industry, where smelters are expecting a quiet time for the remainder of the year. Clydeside representatives of the iron trade read with feelings somewhat akin to envy the reports of continued improvement in the industry on the other side of the border, but, unfortunately, the Scottish shipbuilding industry is still very far from it should be, and until more activity materialises in this section it cannot be expected that the iron and steel works here will be busy. In the Midlands the recent reduction in railway transport charges has, so far, had no effect upon pig-iron quotations, smelters stating that, though acceptable as an instalment, the amount saved—2s. per ton—is insufficient to permit of any concession in prices, which for a long time past have been unprofitable to makers. In the Birmingham market, however, business was rather more difficult to close, but there was nothing really discouraging in the current conditions, which suggested that the enlarged demand for iron is maintained and that smelters may look forward to steady trade on the recent scale, with some prospect of further expansion. In some cases forge iron was 1s. up. Very encouraging reports are in circulation concerning engineering and wagon building, from which improved orders are being received. On Tees-side there is undoubtedly an improvement in the home demand for Cleveland foundry iron, and this can be said in spite of the disposition, always evident at this period of the year, to cut down requirements in view of stock-taking. The general tone is certainly healthier, and this will probably be more fully borne out at the turn of the year. Meanwhile, makers have but little iron to spare, notwithstanding recent expansions in the output, for the bulk of the additional make is going direct into the steelworks. Export business continues to be handicapped by the exchange difficulties, but moderate parcels are changing hands and connections are maintained. There was some fresh American inquiry for the standard quality last week, but any further sustained demand from that quarter is not now generally expected. Another blast-furnace is about to be put in for basic steel purposes. While prices are nominally unchanged at last week's levels, there is an inclination to make some concessions against suitable business. Thus, No. 1 and silicious could now probably be done at about 95s. 6d., compared with a recent figure of 97s. 6d., and No. 3 G.M.B. is obtainable at about 91s. 6d. No. 4 foundry is easy at 87s. 6d., and No. 4 forge at 82s. 6d.

A strong and healthy tone characterises the hematite pig-iron market both on the East Coast and Cumberland. The improvement in the steel trade position is reflected in the increased home demand for hematite in Sheffield, South Wales and other centres, and the outlook for home industrial requirements is certainly much better than at any previous period this year. Substantial forward sales are being made for the first quarter of next year, and makers for the most part are already very comfortably placed, order books being the best evidence of a return of trade confidence. Prices are firmly held. East Coast mixed numbers are quoted at 93s. 6d., with No. 1 6d. to 1s. per ton more. Prices for Cumberland and North Lancashire qualities are unchanged, the current quotation for Bessemer mixed numbers ruling at 105s. to 110s. per ton, delivered Glasgow or Sheffield.

Finished Iron.

The position, as regards finished material, has undergone little change since last reported, but a distinctly more hopeful view of the outlook is entertained in trade circles, where the opinion is now strongly held that the coming year will witness an early revival of business in most iron manufacturing departments. A substantial basis for a more optimistic outlook in the trade is found in the increasing activity in the wagon and engineering industries, which have been very depressed for some time, and their improvement must be reflected in the demand for finished goods. Some trouble is still being experienced owing to keen quotations for imported Belgian iron, but these are more effective as bargaining advantages than from any other point of view, inasmuch as the period required for delivery is somewhat extended, and buyers will not commit themselves so far forward. The remarkable steadiness of prices for so long a period is confirmatory evidence of this. It is satisfactory to learn that the founlry trade will also benefit to a substantial extent by the revival of business in other branches, already indicated, the demand for building castings especially having been adversely affected during the past year by the general depression in trade, which has checked developments in this particular direction.

Steel.

The improvement already noted in various branches of the steel industry is well maintained, although, of course, fresh orders are scarce in volume at a period of the year when stock-taking is in near contemplation. Confirmation of this view is forthcoming in the renewed activity developed recently in buying orders for ferro-alloys, that market at present being inundated with inquiries and orders for delivery over the first quarter of next year. There is no doubt that the publicity given to the statements made at the meeting of the Prime Minister and the railway managers concerning renewal and development policies, which will mean the spending of millions, has quickly had a beneficent effect on trade in that it has increased confidence for the immediate future. The chief interest has been ferro-silicon of 45/50 per cent. grade, and some of the largest inquiries for over twelve months have been put out for immediate settlement, with deliveries varied according to individual requirements. An appreciation of makers' price of this alloy of from 5s. to 10s. came into effect almost simultaneously with the railway announcement, and delivered consumers' works prices are now round £11 7s. 6d. per ton. In the 75 per cent. grade demand is still quiet, but the price is firm at £20 per ton for new stock. In the Sheffield steel market the outlook becomes better each week, and transactions are not only more numerous, but on a larger scale. Business in acid billets is distinctly reviving, and a rise in prices may have to be recorded shortly. It is in basic billets, however, that the greatest activity prevails, and the volume of business shows an appreciable increase. Quotations for these have gone up, and are now : £8 15s. for hard, £8 to £8 5s. for medium, and £7 5s. for soft. It is expected that as a consequence of these higher quotations wire rods and rolled steel will shortly be dearer. At present soft basic wire rods cost £10, and hard ditto £11 10s. and £13 10s.

Scrap.

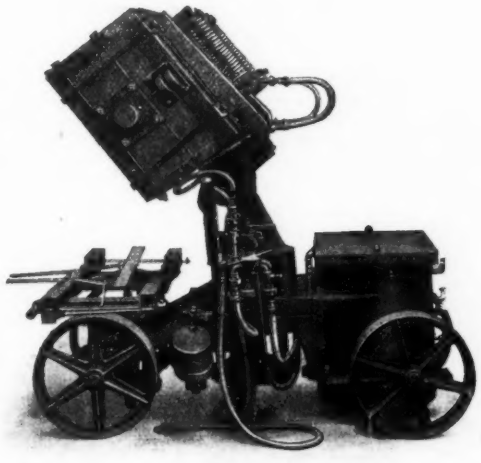
Business in most descriptions of iron and steel scrap has of late taken a distinct turn for the better, the improvement previously noted in the heavier qualities of the latter metal being well maintained, while there is now a more active demand for foundry material, and prices are showing a firmer tendency in other directions. In the Midlands, cast-iron scrap for use in foundries is very firm, and prices have again been increased one or two shillings per ton, especially for the better qualities. At Middlesbrough there is a steadily increasing demand in this district for nearly all descriptions of iron and steel scrap, and prices are showing an upward movement. There is an insistent inquiry for heavy steel scrap, and the price is now fully 71s. per ton. The demand for cast-iron scrap, machinery quality, is improving, and the quotation for this material is now up to 75s. Steel turnings and cast-iron borings are scarce and strong at 55s. to 57s. 6d. Heavy wrought piling iron is stiffer at 72s. 6d., and specially selected heavy forge at 80s. There is practically no demand for bushelling scrap, which is nominal at 65s. All these prices are delivered works.

Metals.

Copper.—Movements in the standard copper market recently have been restricted within a narrow range, fluctuations in values evidencing a quietly steady tendency, on the whole representing little variations of importance from day to day. The home consumptive demand is fairly satisfactory for the end-of-year period, but the disturbance of foreign exchanges still remains a restraining factor in Continental markets. Prices in America remain very steady, the latest quotation being 13.85 cents. The existing immigration laws in the United States, according to the latest reports on the labout situation there, are resulting in a serious shortage of labour being experienced at the mines, and in all big centres of employment. The consequent inability to increase production is to a certain extent offset by the increased imports of copper from South America. Current quotations :—*Cash* : Wednesday,

(*Continued on page 502.*)

MACNAB & CO.



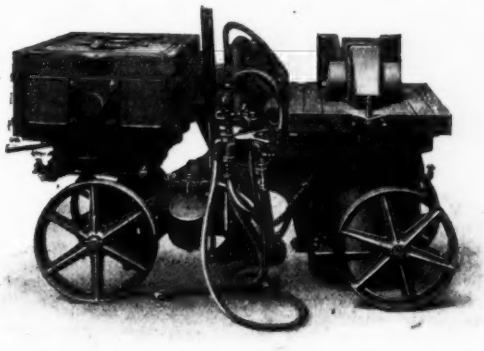
Box and Mould—after being Rammed—in position of being Rolled over

Tabor Patent
Portable
Combination
Shockless Jarring
Roll - over
AND
Pattern - Drawing

MOULDING MACHINE

Capacities and Dimensions furnished upon application.

We make various models and sizes for all types of machine moulding, according to class of work and numbers.



The Finished Mould—showing Pattern after being drawn.

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Works: TOTTENHAM, LONDON, N.17.

IRON AND STEEL MARKETS.—*Continued.*

£62 7s. 6d.; Thursday, £62 10s., Friday, £62 10s.; Monday, £62 12s. 6d.; Tuesday, £62 10s. *Three months:* Wednesday, £63 2s. 6d.; Thursday, £63 5s.; Friday, £63 2s. 6d.; Monday, £63 5s.; Tuesday, £63 5s.

Tin.—The market for standard tin has recently developed a more irregular tendency, and variations in values have been inclined to lower levels than those obtaining last month. The statistical position is fairly satisfactory on the whole, showing, according to Messrs. Ricard & Freiwald's report for November, as follows:—STOCKS, LANDING AND AFLOAT, EUROPE AND AMERICA: United Kingdom, stocks in London, 4,001 tons; stocks in other ports, 1,376 tons; total, 5,377 tons; landing and in transit, 335 tons; afloat from Straits, 695 tons; afloat from Australia, 125 tons; total United Kingdom, 6,532 tons. HOLLAND; Banca spot, 2,395 tons; Banca and/or Billiton afloat to Europe and America, 1,545 tons. CONTINENT: Straits afloat, 1,445 tons. UNITED STATES: Spot and landing, 2,699 tons; afloat, 7,730 tons. Total visible supply, 22,346 tons. Current quotations:—*Cash*: Wednesday, £179 5s.; Thursday, £180 2s. 6d.; Friday, £180 15s.; Monday, £178 17s. 6d.; Tuesday, £175 10s. *Three months:* Wednesday, £180 10s.; Thursday, £181 2s. 6d.; Friday, £181 15s.; Monday, £179 17s. 6d.; Tuesday, £176 15s.

Spelter.—In the market for this metal a sharp recovery has eventuated in current values, an outstanding feature of movements having been a substantial recovery in forward dealings, for which there is a steady demand. According to The American Institute the world's output of zinc for 1922 is estimated at 311,500 tons, excluding America, which compares with the pre-war output, excluding America, of 675,000 tons. The U.S.A. production for 1921 is given as 200,500 tons. Current quotations:—*Ordinary*: Wednesday, nominal; Thursday, nominal; Friday, £40; Monday, £39 10s.; Tuesday, nominal.

Lead.—There is little change to report in this market of late, but a noticeable feature is the weakness of the near and the firmness of the distant position. A rather better demand has been experienced from home consumers, but supplies have been ample to meet all immediate requirements. The forward position, in this respect, is not so satisfactory, as there are no indications at present of increased supplies from any quarter. Current quotations:—*Soft foreign (prompt)*: Wednesday, £25 17s. 6d.; Thursday, £25 17s. 6d.; Friday, £26; Monday, £26; Tuesday, £26 2s. 6d.

Trade Talk.

SOME 100 moulders on Tees-side are on strike as a protest against a wage reduction.

OVER seven hundred men are thrown out of work by the closing of the Leeds Steelworks for an indefinite period.

THE CALPHOS ELECTRICAL COMPANY, LIMITED, have removed to 70, Victoria Street, Westminster, London, S.W.1.

THE BELGIAN ACIERIES D'ANGLEUR have booked an order for 5,000 tons of rails and fastenings for the Polish railways.

M. C. GOODING & COMPANY, engineers, formerly of Jubilee Works, George Street, have removed to 78, Keens Road, South Croydon.

THE men employed at the Albion Steelworks, owned by the Briton Ferry Steel Company, Limited, have received notices varying from 14 to 28 days to terminate work.

MR. GEORGE W. MARTIN, consulting engineer, has removed his city office from 5, Great James Street, Bedford Row, to Sentinel House, Southampton Row, London, W.C.1.

BELL BROS. (MANCHESTER), LIMITED, have transferred their works at Ravensthorpe, Yorks, and their city office at 5, Deansgate, Manchester, to the Calder Ironworks, Denton, Manchester.

JAMES HARGREAVES & SONS (LEEDS), LIMITED, have removed their London offices from 6, Broad Street Place, E.C.2, to Finsbury Court (Western Corridor), Finsbury Pavement, London, E.C.2.

THE STEELWORKS of the Skinningrove Iron Company, Limited, will probably be restarted this month, after a very long period of inactivity. A third blast-furnace and a battery of coke ovens are also to be put into operation.

A DISPUTE concerning the wages of furnace bricklayers and bricklayers' labourers, which began last February, is officially ended to permit of national negotiations between the employers' and the workers' organisations.

THE BLAENAVON COMPANY, LIMITED, state that their scheme of works extensions is almost complete. The principal capital expenditure during the past year has been on the gas cleaning plant and new Rateau blower and condenser.

THE OLD-ESTABLISHED business of Shand, Mason & Company, fire engine makers, of Blackfriars, has been purchased by, and is now incorporated with, Merryweather & Sons, Limited, of Greenwich Road, London, S.E.10.

THE wages regulated by the sliding scale under the Midland Iron and Steel Wages Board were advanced 2½ per cent. from Monday, December 4, and the new rate will remain in operation until Saturday, February 3, 1923.

THE VULCAN FOUNDRY, LIMITED, are supplying twelve 4-6-0 type M. class and ten 4-6-0 S.G. class locomotive for metre-gauge lines to the South Indian Railway, and 27 goods type locomotives to the Great Indian Peninsula Railway.

THE executive of the Amalgamated Engineering Union met the Engineering Employers' Federation, in London on December 1, to discuss the question of payment for work done on holidays. The conference lasted throughout the day, and at the conclusion it was officially announced that a joint recommendation had been agreed upon, and would be submitted in due course to the constituent bodies of both sides for ratification.

MANY of the war-blinded men at St. Dunstan's have been very thoroughly trained as telephone operators, and have successfully filled positions all over the country in this capacity. Five or six of these men are waiting for positions at the present time, and the secretary of St. Dunstan's After-Care Organisation at the Headquarters of St. Dunstan's Work, Regent's Park, N.W.1, will supply information to those able to engage a blinded soldier as telephone operator.

E. CAPPER ROBSON & COMPANY, LIMITED, 1, North Road, Darlington, Durham, announce that the note published in the early part of the month, to the effect that they will in future trade as Robson Refractories, Limited, is incorrect, as Robson Refractories, Limited, are distinctly a separate company. Robson Refractories, Limited, were formed for the purpose of controlling "Cupoline" in this country, the selling rights of which were previously held by E. Capper Robson & Company, Limited, but the latter will continue to trade as E. Capper Robson & Company, Limited, as hitherto.

THE general secretary of the National Federated Electrical Association has written to all members of that body instructing them to put into effect the second 5 per cent. reduction on the April, 1921, rates. This follows on an intimation by Mr. Rowan, the secretary of the Electrical Trades Union, that the result of the ballot vote of that union is in favour of accepting the recommendation agreed upon by negotiation. The reduction will take effect on the first pay day following Sunday, January 7, when the rates will be: Grade A, 1s. 9½d. (this rate includes a travelling allowance. No further allowances to be paid except as provided by Rule 9 of the London Rules, dated February, 1920); Grade B, 1s. 6¼d.; Grade C, 1s. 5d.; Grade D, 1s. 3¾d.

Another International Foundry Trades Exhibition.

Arrangements have now been made by the Birmingham Chamber of Commerce, in conjunction with the British Cast Iron Research Association, to hold an International Foundry Trades Exhibition at Birmingham in the early summer of 1924, and every effort will be made to make it as comprehensive as possible. It will be remembered that the Exhibition of 1922 was the first of its kind in this country and was an exceptional success. Steps will be taken to ensure a greater international representation at the 1924 Exhibition, and arrangements will be made to increase the schedule of the Foundry Employees' Competitions, which were so very successful. The Chamber of Commerce are to be congratulated upon their early decision to bring together a further Exhibition to improve the foundry industry.

Growth of the I.B.F.—Over 70 members, associate members and associates were elected at a meeting of the Council of the Institution of British Foundrymen, held in York last Saturday.

The American National Founders' Association are petitioning the President and Congress of the United States for an alteration in the present immigration laws, as they believe there is a grave danger of a serious shortage in foundry labour in the near future.

SHOTTS IRON COMPANY, LTD.,

1, Castle St., Edinburgh.

Telephone: 8632 Cent. Telegrams: "Shotts" Edinburgh.

Branch Office—

141, West George St., Glasgow.

Approximate Analyses of SHOTTS Foundry and Forge PIG IRON

	No 1.	No. 3.			No. 4.			
	Per cent.	Soft. Per cent.	Medium Per cent.	Hard. Per cent.	Soft. Per cent.	Hard Per cent.	Mottled. Per cent.	White. Per cent.
Iron	91.57	92.21	92.31	92.46	92.83	93.75	93.85	94.14
Graphite	3.25	3.00	2.98	2.90	2.95	2.60	2.00	0.60
Combined Carbon	0.18	0.23	0.33	0.45	0.50	0.60	1.50	2.80
Silicon	3.25	2.80	2.60	2.40	2.00	1.40	0.90	0.56
Sulphur	0.02	0.03	0.05	0.06	0.07	0.10	0.15	0.30
Phosphorus	0.80	0.80	0.80	0.80	0.72	0.70	0 70	0.70
Manganese	0.93	0.93	0.93	0.93	0.93	0.85	0.90	0.90

In addition to PIG IRON we are producers of the following:—

COAL for Steam, Gas and Household purposes.
LIMESTONE for Blast Furnaces and Foundries.
LIME for Building, agricultural purposes, etc.
SHOTTS BRICK for building purposes.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR, nr. SHEFFIELD.

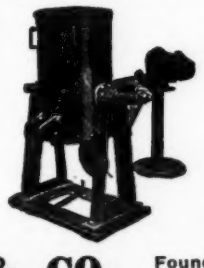
Telegrams: "LOWOOD, DEEPCAR."

GREEN'S EMERGENCY CUPOLA IS A GREAT MONEY SAVER

Sizes from 5 to 40 cwts. capacity per hour.

GREEN'S STEEL CONVERTER PLANTS ARE SECOND TO NONE.

COMPLETE FOUNDRY MELTING EQUIPMENTS
FOR DEALING WITH
CAST IRON, STEEL, AND BRASS
ARE OUR SPECIALITY.



Green's Rapid "Economic" CUPOLA is the last word in Cupola design.

Hundreds of Highly Satisfied Users will confirm this

Ask for complete Catalogue of Foundry Plant, and file for future reference.

GEORGE GREEN & CO., Foundry Engineers and Contractors, KEIGHLEY.

Telegrams: "Cupola." Telephone: 518. Codes: Western Union, Lieber's 5-letter Code, Marconi International.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	62	10	0
Three months	63	5	0
Electrolytic	69	0	0
Tough	65	15	0
Best selected	65	15	0
Sheets	96	0	0
India	84	0	0
Wire bars	69	12	6
Do. Jan.	69	12	6
Do. Feb.	69	12	6
Ingot bars	69	2	6
H.C. wire rods	73	15	0
Off. aver. cash Nov.	62	17	0 6/11
Do. 3 mths., Nov.	63	14	3 9/11
Do. Settlement Nov.	62	17	1 10/11
Do. Electro, Nov.	70	9	3 9/11
Do. B.S., Nov.	66	8	9
Aver. spot price, copper, Nov.	62	16	1 3/4
Do. Electro, Nov.	70	14	3 1/4

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10½d.
Yellow metal rods 6¾d.
Do. 4x4 Squares 8½d.
Do. 4x3 Sheets 9½d

BRASS.

Solid drawn tubes 11½d.
Brazed tubes 13½d
Rods, drawn 10½d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. 10d.
Wire 9½d.
Rolled metal 9½d.

TIN.

Standard cash	175	10	0
Three Months	176	15	0
English	175	10	0
Bars	177	10	0
Chinese	174	5	0
Straits	177	5	0
Australian	176	15	0
Eastern	181	0	0
Banca	176	5	0
Off. aver., cash Nov.	179	8	9 5/8
Do. 3 mths., Nov.	180	3	5 3/8
Do. Settlment Nov.	179	8	7 7/11
Aver. spot, Nov.	179	7	3 1/4

SPELTER.

Ordinary	Nominal		
Remelted	36	0	0
Hard	28	0	0
Electro 99.9	44	0	0
English	39	10	0
India	29	0	0
Prime Western	39	10	0
Zinc dust	49	0	0
Zinc ashes	11	0	0
Off. aver., Nov.	36	18	9
Aver., spot, Nov.	38	0	2 3/4

LEAD.

Soft foreign ppt	26	2	5
English	27	5	0
Off. average, Nov.	25	12	2 3/22
Average spot, Nov.	26	3	5½

ZINC SHEETS, &c.

Zinc sheets, English	42	0	0
Do. V.M. ex. whf.	43	0	0
Dutch	43	0	0
Rods	50	0	0
Boiler plates	41	0	0
Battery plates	43	0	0

ANTIMONY.

English regulus	27	0	0
Special brands	33	10	0
Chinese	25	0	0
Crude	17	0	0

QUICKSILVER.

Quicksilver 12 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 11 7 6
75% 20 0 0

Ferro-vanadium—
35/40% 17/- lb. va.

Ferro-molybdenum—
70/75% c. free 9/6 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/2½ lb.

Ferro-phosphorus, 20/23%, £24

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% 1/11 lb.

Ferro-chrome—
4/6% car. £22 0
6/8% car. £21 10
8/10% car. £20 0

Ferro-chrome—
Max. 2% car. £54 0
Max. 1% car. £65 0
Max. 0.70% car. £73 0
67/70%, carbonless 1/7 lb.

Nickel—99%, cubes or pellets £130 0

Cobalt metal—98/99% 11/6 lb.

Aluminium—98/99% £100

Metallic Chromium—
96/98% 4/6 lb.

Ferro-manganese(net)—
76/80%, loose £15
76/80%, packed £16
76/80%, export £14 10

Metallic manganese—
94/96%, carbonless 2/3 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten s. d. 2 6
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ¼ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d	£	s.	d
Heavy Steel	3	16	0	4	2	6
Bundled steel & shearings	3	2	6	3	17	6
Mixed iron & steel	3	5	0	3	10	0
Heavy cast iron	3	12	6	3	17	6
Good machinery for foundries				4	6	0

Cleveland—			
Heavy steel	3	10	0
Steel turnings	2	16	0
Cast-iron borings	2	15	0
Heavy forge	3	13	9
Bushelled scrap	2	16	3
Cast-iron scrap	3	13	9

Lancashire—			
Cast iron scrap	3	15	0
Heavy wrought	3	2	6
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	57	0	0
Brass (clean)	32	0	0
Lead (less usual draft)	22	0	0
Tea lead	20	0	0
Zinc	23	0	0
New aluminium cuttings	64	0	0
Braziery copper	48	0	0
Gun metal	44	0	0
Hollow pewter	150	0	0
Shaped black pewter	90	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	95/6
Foundry No. 3	91/6
Forge No. 4	82/6
Mottled	81/6
Hematite No. 1	94/3
Hematite M/Nos.	93/6
Midlands—	
Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast, ord.	190/-
„ „ roll iron	200/-
„ basic	—
Northants forge	70/- to 72/6
„ foundry No. 3	77/6 „ 80/-
„ basic	80/-
Derbyshire forge	75/-
„ foundry No. 3	82/6
„ basic	80/-
Scotland—	
Foundry No. 1	99/6
„ No. 3	94/6
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	85/6
„ foundry No. 3	87/6
Lincs. forge	86/6
„ foundry No. 3	87/6
„ basic	86/6
E.C. hematite	104/8
W.C. hematite	110/-
All d/d in the district.	
Lancashire (d/d eq. Man.) —	
Derby forge	—
„ foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	109/6
Glengarnock foundry	111/6
Gartsherrie foundry	111/6
Monkland foundry	109/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 10 to 11	10	0
Angles	£10 15 to 11	15	0
Tees to 3 united ins.	£11 to £12		
Nut and bolt	9	12	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	£10 10 to 10	15	0
Bolts and nuts, ¾ in. × 4 in.	16	10	0

Steel—			
Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	5	0
Angles	£8 12 6 to 9	0	0
Tees	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	5	0
Rounds, under 3in. to ¾in.	8	15	0
Flats, over 5in. wide and up	9	10	0
Flats 5in. to 1½in.	8	15	0

	£	s.	d
Rails, heavy	8	15	0
Fishplates	13	10	0
Hoops	11	10	0
Black sheets, 24 g.	11	15	0
Galv. cor. sheets, 24 g.	17	7	6
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ½ in. dia	11	15	0
Billets, soft	6 10 0 to 7	0	0
Billets, hard	7 0 0 to 8	0	0
Sheet bar	6 17 6 to 7	13	9

PHOSPHOR BRONZE.

	Per lb basis
Strip	1 3
Sheet	1 3¼
Wire	1 3½
Rods	1 2¼
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	29.14
No. 2 foundry Valley	27.00
No. 2 foundry, Birm.	23.00
Basic	28.46
Bessemer	32.27
Malleable	29.96
Grey forge	28.27
Ferro-manganese 80 % delivered	100.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	37.00
O.-h. billets	37.00
O.-h. sheet bars	37.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.27
Steel bars	2.00
Tank plates	1.95
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/-
„ furnace	25/-
Durham & North. fdy.	27/6 to 30/-
„ furnace	22/6 to 25/6
Other Districts, foundry	25/- to 30/-
furnace	21/6 to 24/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

	£ s. d.
Rolled Ordinary—Assortment ..	18 0 0
Nail Rods—Square, round and flats ..	to 18 10 0

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	.. 57½%	Tube prices are now free.
Water	.. 52½%	
Steam	.. 47½%	

TINPLATES.

I.C. Cokes,	20×14, box	20/–
„	28×20, „	40/6
„	20×10, „	29/–
„	18¾×14, „	20/6
I.X.	„	46/–
I.X.X.	„	52/–
F.C.B.Y.	21×13⅝ „	36/9
C.V.B.G.	16¼×15, „	35/–
I.C.W.	20×14, „	17/10½
„	28×20, „	36/–
„	20×10, „	25/9
„	18¾×14, „	18/6
Terneplates,	28×20, „	37/–

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Dec. 6	62	7	6	inc.	2/6
„ 7	62	10	0	„	2/6
„ 8	62	10	0	No change	
„ 11	62	12	6	inc.	2/6
„ 12	62	10	0	dec.	2/6

Electrolytic Copper.

Dec. 6	69	10	0	inc.	2/6
„ 7	69	10	0	No change	
„ 8	69	10	0	„	
„ 11	69	10	0	„	
„ 12	69	0	0	dec.	10/–

Standard Tin (cash).

Dec. 6	179	5	0	inc.	65/–
„ 7	180	2	6	„	17/6
„ 8	180	15	0	„	12/6
„ 11	178	17	6	dec.	37/6
„ 12	175	10	0	„	67/6

Tin (English ingots)

Dec. 6	179	5	0	inc.	65/–
Dec. 7	180	5	0	inc.	20/–
„ 8	181	0	0	„	15/–
„ 11	180	0	0	dec.	20/–
„ 12	175	10	0	„	90/–

Zinc Sheets (English)

Dec. 6	41	10	0	No change	
„ 7	41	10	0	„	
„ 8	42	0	0	inc.	10/–
„ 11	42	0	0	No change	
„ 12	42	0	0	„	

Spelter (ordinary)

Dec. 6	—				Nominal
„ 7	—				„
„ 8	40	0	0	No change	
„ 11	39	10	0	dec.	10/–
„ 12	—				Nominal

Lead (English)

Dec. 6	27	5	0	No change	
„ 7	27	5	0	„	
„ 8	27	5	0	„	
„ 11	27	5	0	„	
„ 12	27	5	0	„	

There's something for You among these —

Blacking, Coal Dust, Plumbago, Charcoal, Core Gum, Terra Flake, Gannister, Core Oils, Sea Sand, Moulding Sand, Iron Cement, Brushes, Bellows, Buckets, Chaplets, Core Ropes, Core Tapers, Ladles, Crucibles, Cupolas, Riddles, Sprigs, Spades, Carborundum Bricks and Wheels, Ferro-Aluminium, Blacking Bags, Foundry Plant, Etc., Etc., Etc.

F. L. HUNT & CO., 56, 58, 60, Chapel Street, Salford, Manchester.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK
LIMPET

1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

LATE PRODUCTION MANAGER of well-known firm desires position; experience in Engine and Ordnance Work, Colliery and General Engineering.—Apply, W. LAING, 4, Main Road, Handsworth, Sheffield.

WANTED.—FOUNDRY FOREMAN, experienced in moulding large marine castings and general heavy machine tool castings.—Apply, THE SHEEPBRIDGE COAL & IRON COMPANY, LIMITED, Chesterfield.

WANTED, Foreman for Aluminium Foundry. Must have good experience in this metal and be good organiser, with intimate knowledge of modern machine moulding. Only keen men need apply.—Box 312, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—FOREMAN PATTERNMAKER, experienced in heavy marine engine, general machine tools and special pipe patterns.—Apply, THE SHEEPBRIDGE COAL & IRON COMPANY, LIMITED, Chesterfield.

SALE BY AUCTION.

ON VIEW MONDAY. SALE TUESDAY NEXT.

THE STOWAGE, DEPTFORD.

The remaining FOUNDRY & FORGING

PLANT AND MACHINERY

OF MESSRS. FORGINGS, LIMITED,

including 3 powerful TRIMMING PRESSES, by Massey, and John Hands, a "Brayshaw" air-blast GAS FURNACE, a "Climax" portable Smith's hearth with rotary blower and electric motor; "Monometer," "Sturtevant," and other blowers, vice, anvil, swage block and stands, 79 new Morgan's "SALAMANDER" CRUCIBLES and bases, five 0-1200 Pyrometers, two 7 ft. by 3 ft. ¼th plate galvanised iron cylinders, one 200-gal. galv. open cistern, one 500-gal. welded wt. iron tank with steam coil, Albany pump, power grindstone, five sets of 800-lb. Lip-Axis type MONOMETER MELTING FURNACES, range of three INCANDESCENT HEAT OVENS, etc., dismantled and including upwards of 40 TONS of heavy WT. and CAST SCRAP, steel shafting, large steel and wood split pulleys, belting, upwards of 40 TONS NEW TOOL & DIE STEEL & BILLETS, 10 tons of steel press dies, two sets of "Climax" 1-ton lifting tackle, 40 box and flat top Foundry Bogies, the fittings for a 12-ft. lift, sets of women's new factory overalls, ambulance stretchers, a nearly-new "Criterion" 3-oven gas-cooking range, steam boilers, office fittings, and numerous effects, which will be SOLD BY AUCTION by Messrs.

J. T. SKELDING & CO.,

at "The Duke" P.H., 125, CREEK ROAD, DEPTFORD, S.E. (by kind permission), on TUESDAY, DECEMBER 19, 1922, at 12 o'clock, sharp. Catalogues of the Auctioneers, 48, Gresham Street, Guildhall, E.C.2.

TENDERS

GREAT WESTERN RAILWAY.

The Directors of this Company are prepared to receive tenders for the supply of the undermentioned Stores from the 1st of January, 1923, to the 30th of June, 1923.

1.—Laminated Springs.
2.—Helical and Volute Springs.
3.—Steel Tyres.
4.—Steel Axles and Forgings.
5.—Iron Plates and Bars.
6.—Steel Plates and Sheets.
7.—Steel Bars and Blooms.
8.—Steel Castings (Wheel Centres and Bosses).
9.— Do. (Miscellaneous).
11.—Chain and Special Iron for Chain Manufacture.
12.—Tubes and Fittings.
13.—Solid Drawn Steel Tubes.
14.—Cast Iron Socket Pipes, Lamp Posts, &c.
15.—Galvanized Sheets.
16.—Tool Steel.

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Tenders addressed to the undersigned and marked outside "Tender for Iron and Steel" will be received not later than 10.0 a.m. on Thursday, the 21st December, 1922.

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